Staff Report of the

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

CENTRAL VALLEY REGION

AGRICULTURAL DRAINAGE CONTRIBUTION TO WATER QUALITY IN THE GRASSLAND AREA OF WESTERN MERCED COUNTY, CALIFORNIA: OCTOBER 1993 TO SEPTEMBER 1994

(WATER YEAR 1994)

JANUARY 1995

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EXECUTIVE SUMMARY AND RECOMMENDATIONS

In May 1985, Regional Board staff began a water quality monitoring program to evaluate the effects of subsurface agricultural drainage on the water quality of the drains in the Grassland Area of western Merced County. This database is used in the development of future agricultural drainage reduction programs in the San Joaquin River Basin. Reports on this water quality survey have already been prepared and approved by the Board for Water Year (WY) 1986 through 1992. The current report covers WY 94 (October 1993 through September 1994), a critical runoff water year.

Agricultural lands east, west, and south of the Grassland Area discharge subsurface agricultural drainage water (tile drainage) and surface irrigation runoff (tail water) to the Grassland Area. This drainage often contains high concentrations of salts, selenium, and other trace elements. This regional drainage flows north through the Grassland Area where it is carried by a network of canals which can divert water in a number of possible ways before it reaches Mud Slough (north) or Salt Slough and ultimately the San Joaquin River.

As in previous studies, this study shows that the highest constituent concentrations are found at the inflow monitoring stations near the southern boundary of the Grassland Area. This inflow is generally a blend of subsurface tile drainage and surface runoff or operational spills from irrigation canals. Four of these inflow points carry a substantial portion of subsurface drainage water and have the highest concentrations of salts, boron, and selenium. Other inflows contain little selenium; however, elevated levels of salt and boron are present.

Water quality objectives are established in the San Joaquin River Basin Plan 5C for selenium, boron, and molybdenum in Mud Slough (north) and Salt Slough. The Basin Plan selenium objective, which became effective in October 1993, is 10 μg/L based on a monthly mean. The selenium levels in the sloughs vary depending on which slough is conveying subsurface drainage from the Drainage Study Area[1] (DSA). During WY 94, subsurface drainage was diverted primarily to Salt Slough. The presence of subsurface drainage in Salt Slough resulted in monthly mean selenium concentrations ranging between 4 and 33 μg/L. The concentration of selenium varied with the concentration in the subsurface drainage and with dilution of the drainage by other sources of flow in the slough. In the absence of significant subsurface drainage discharges to Mud Slough (north), monthly mean selenium levels were less than

[1] Subsurface drainage from the Drainage Study Area will hereafter be referred to as subsurface drainage. Subsurface drainage is composed of subsurface tile discharges from all of the Broadview, Pacheco, and Widren Water Districts (WD); all of the Panoche Drainage District and Firebaugh Canal Company; and about 7% of the area served by the San Luis WD and the Central California Irrigation District.

1.5 μg/L for WY 94. The management of subsurface drainage into either slough is the main factor determining whether the selenium water quality objective will be met.

The seasonal boron objective is 2.0 mg/L (March 15 to September 15) and the molybdenum objective is 19 μg/L for both sloughs, based on a monthly mean. Despite the absence of significant subsurface drainage discharges to Mud Slough (north) water quality objectives were exceeded on a seasonal basis for boron and molybdenum. This observation indicates sources of elevated boron and molybdenum in Mud Slough (north), other than subsurface drainage. The objectives for these constituents may need to be revised for Mud Slough (north) based on background concentrations of these elements in the slough itself.

In Salt Slough, the boron objective was exceeded between March and August 1994. Subsurface drainage was one of the primary components of flow in Salt Slough during this period. Data from WYs 91 and 92 indicate that boron concentrations of 2.0 mg/L can be met in Salt Slough when subsurface drainage is excluded. The molybdenum objective was met at all times in Salt Slough.

An analysis of loads of selenium, boron, and salt from the sloughs and the DSA indicates that the trend toward load reductions which took place between water years 1989 and 1992, was reversed in WYs 93 and 94. Loads of selenium, boron, and salts were only slightly less in WY 94 and WY 93. WY 93 saw increased water supplies in the area with resulting higher discharges and loads. The high load levels continued during WY 94 in spite of the fact that exchange and federal contractors had their contract deliveries curtailed to near WY 92 drought levels. The WY 94 load levels measured were similar to pre-WY 90, when Basin Plan amendments were adopted for control of subsurface drainage discharges to the San Joaquin River. The continuation of elevated load levels in WY 94 may be attributed to pre-plant irrigation and soil salt leaching which would correspond to the extremely high loads originating from agricultural discharges in February and March. The selenium loads generated during the typical pre-planting irrigation season accounted for nearly half of the load produced in WY 94.

Channels which carry supply water for wetland maintenance were monitored weekly during the wetland flooding period in October and monthly thereafter. All supply sources had selenium concentrations below the 2.0 μg/L waterfowl habitat water quality objective during the principal flooding period (October). Selenium concentrations did, however, exceed the waterfowl habitat objective in several of the subsequent monthly measurements in the CCID Main Canal reaching a maximum concentration of 3.8 μg/L. It can not be determined if water exceeding the objective was used for wetland maintenance. The source of the selenium in the supply channels is unknown but may have originated in the Delta-Mendota Canal.

Other constituents analyzed during WY 94 (copper, chromium, lead, nickel, and zinc), do not appear to be at concentrations which would impact aquatic life due to the elevated hardness values in the channels surveyed. Selenium, boron, and salt loads as well as concentrations will continue to be reviewed and analyzed in future water years.

INTRODUCTION

The Agricultural Unit of the Central Valley Regional Water Quality Control Board (Regional Board) initiated a water quality monitoring program in May 1985 to evaluate the effects of subsurface agricultural drainage on the water quality of canals, drains, and sloughs in the Grassland Area in western Merced County. The study area is located west of the San Joaquin River between Newman and Oro Loma, in the San Joaquin River Basin in California (Figure 1). The primary purpose of this monitoring program is to compile an on-going database for selected inorganic constituents found in the agricultural drains discharging to and flowing through the Grassland Area. This database is used in the development and evaluation of agricultural drainage reduction programs in the San Joaquin River Basin. Information gathered under this program is also being used to develop a predictive model for determining maximum salt, selenium, and boron loads which could be discharged from the study area while still meeting downstream water quality objectives (Karkoski, 1994). This report contains laboratory results and a brief summary of the water quality analysis for samples collected during Water Year 1994 (WY 94) (October 1993 through September 1994). Seven previous reports (James, et al., 1988, Chilcott, et al., 1989, Westcot, et al., 1990, Westcot, et al., 1991, Westcot, et al., 1992, Karkoski and Tucker, 1993, and Chilcott et al., 1995) present data for the period May 1985 through September 1993 (WYs 86-93).

STUDY AREA

The Grassland Area encompasses the Northern and Southern Divisions of the Grassland Water District and the farmlands adjacent to the District (Figure 1). Land in this area is primarily used for irrigated agriculture and managed wetlands.

Agricultural lands east, west, and south of the Grassland Area discharge subsurface agricultural drainage water (tile drainage) and surface runoff (irrigation tail water) to the Grassland Area. This drainage often contains high concentrations of salts, selenium, and other trace elements. This regional drainage flows north through the Grassland Area where it is carried by a network of canals that can divert water in several possible ways before it reaches Mud Slough (north) or Salt Slough and ultimately the San Joaquin River.

There were 32 stations in the Grassland monitoring program as described by James, et al., 1988. They were divided into three categories: inflows to, internal flows within, and outflows from the Grassland Area. Inflow monitoring stations were located on drains that discharge into the Grassland Area and are mainly located at the southern end of the study area. Monitoring stations on the internal flow canals were located on drains within the Grassland Area that carry or could carry subsurface tile drainage as it passes through the area before discharging to the San Joaquin River. Outflow monitoring stations were located where drains or natural waterways flow out of the Grassland Area. Many of the internal flow stations described by James, et al. (1988), have been altered or dropped from the original monitoring program.

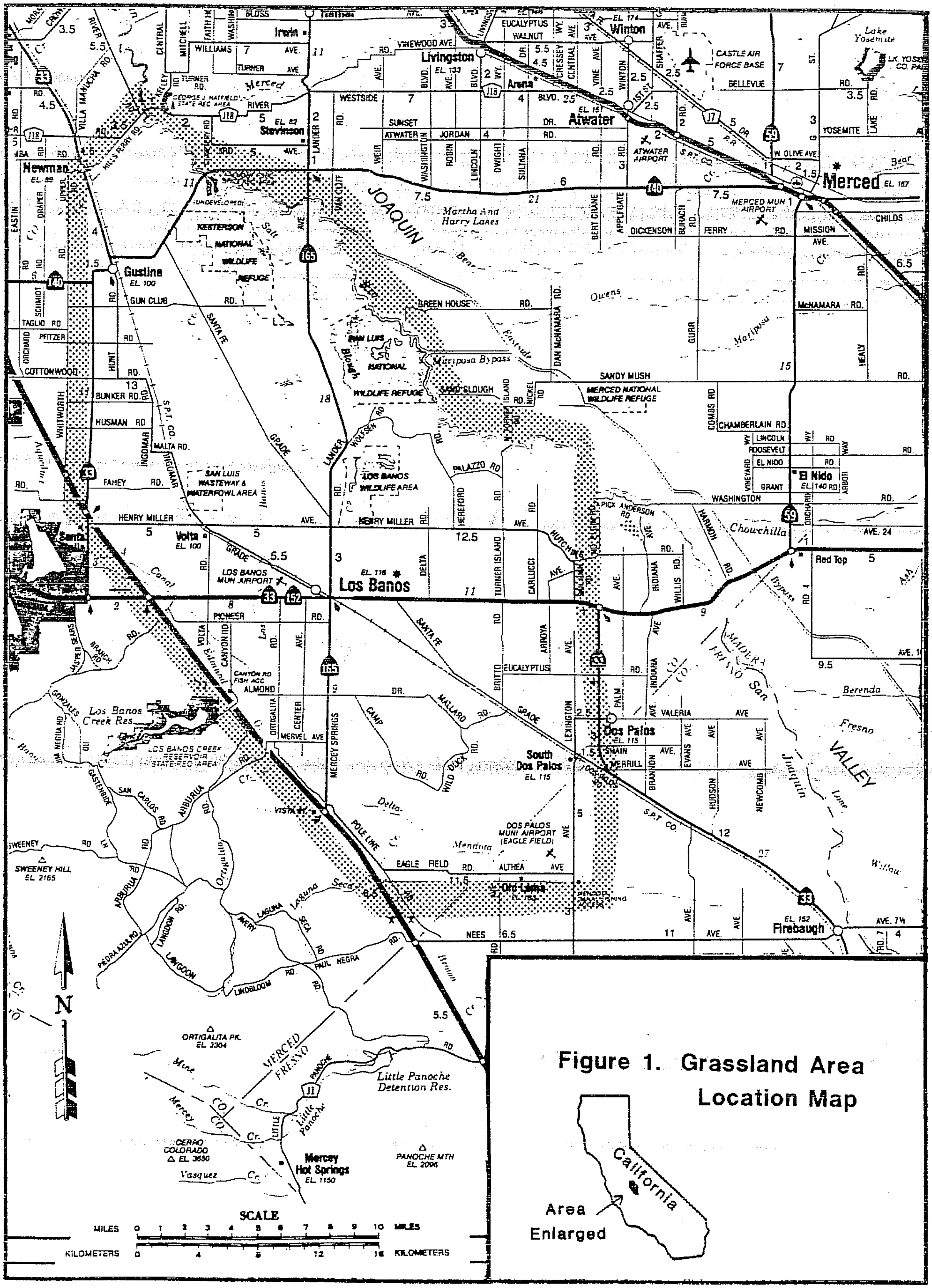

Figure 1. Grassland Area Location Map

During WY 94, 10 inflow, six internal flow, and four outflow stations were monitored (Table 1 and Figure 2). Most of the original inflow stations were maintained during the current survey and have continuous data from May 1985 through September 1994. Internal flow stations are maintained to assess the approximate concentration of selenium in water supply canals to the Grassland Area as well as to track movement of the drainage water. The CCID Main Canal (T-1) is the main supply to the Grassland Area and local duck clubs and is discussed in this report. The Porter-Blake Bypass (T-13), Santa Fe Canal at Henry Miller Road (T-5), San Luis Canal at Henry Miller Road (T-7A), San Luis Canal at Highway 152 (T-7), and San Luis Spillway Ditch at Santa Fe Grade (T-14) were also surveyed during WY 94.

Mud Slough (north) and Salt Slough are the only two tributaries to the San Joaquin River which drain the Grassland Area and are described in detail by James, et al. (1988) and Pierson, et al. (1989a and 1989b). Mud Slough (north) at the San Luis Drain (0-2A) and Salt Slough at Lander Avenue (0-4) tie in with the continuous flow monitoring stations operated by the U.S. Geologic Survey and are the principal stations in this monitoring program. These two sites best represent the water quality of the drainage leaving the Grassland Area. Los Banos Creek at Highway 140 (0-3) drains into Mud Slough (north) upstream of the San Joaquin River but downstream of the site near the San Luis Drain. Mud Slough at Newman Gun Club (0-1) represents the combined quality of Mud Slough (north) and Los Banos Creek.

METHODS

Sampling

The frequency of sample collection for this monitoring program consisted of weekly and monthly grab samples. Water temperature, pH, electrical conductivity (EC), and sample time were recorded in the field for each site. There were 10 sites sampled weekly and an additional 13 sites sampled monthly. Laboratory analyses for total recoverable selenium, boron and EC[2] were performed on all samples. Selected sites were also monitored for copper, chromium, nickel, lead, zinc and molybdenum on a monthly basis. Samples were collected in polyethylene bottles. The selenium and trace element sample bottles were rinsed with dilute nitric acid and de-ionized water in the laboratory before use. All sample bottles were rinsed three times with the water to be sampled prior to sample collection. Selenium and trace element samples were preserved by lowering the pH to less than two using reagent grade nitric acid. All samples were kept on ice until preservation or submittal for analyses.

A quality control and quality assurance program was conducted using blind spiked and split samples. Blind split samples were collected at 10 percent frequency, and half of the blind splits were spiked with known concentrations of key constituents to evaluate analytical

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[2] Electrical conductivity values reported in the Appendices are laboratory EC values.

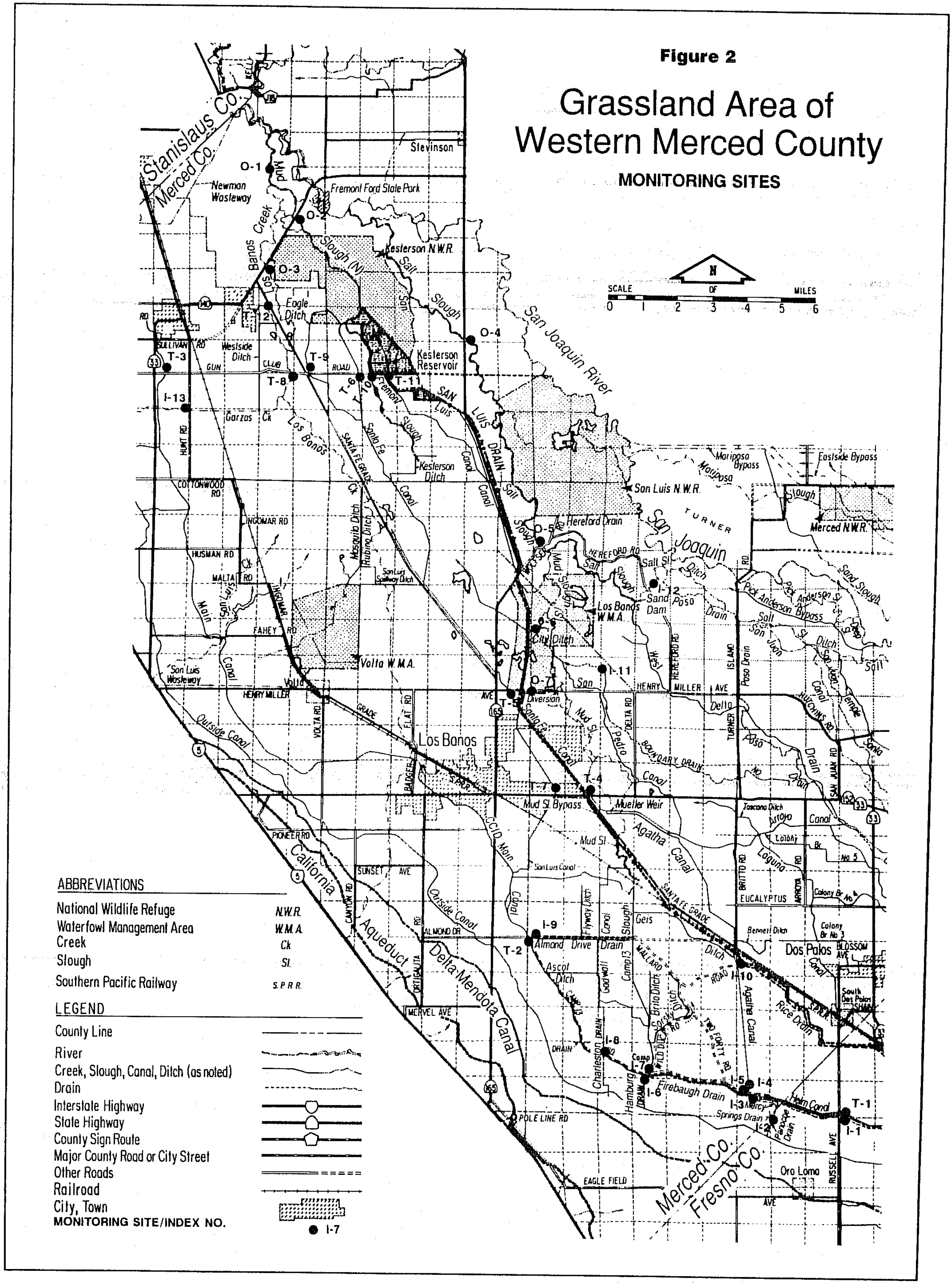
Table 1. Water Quality Monitoring Sites in the Grassland Area for Water Year 1994.

Map Index	RWQCB Site I.D.	Site Name	Site Type
I-1	MER 556	Main (Firebaugh) Drain @ Russell Ave.	Inflow
I-2	MER 501	Panoche Drain	Inflow
I-4	MER 506	Agatha Canal @ Mallard Rd.	Inflow
I-6	MER 504	Hamburg Drain	Inflow
I-7	MER 505	Camp 13 Slough	Inflow
I-8	MER 502	Charleston Drain	Inflow
I-9	MER 555	Almond Drive Drain	Inflow
I-10	MER 509	Rice Drain	Inflow
I-11	MER 521	Boundary Drain	Inflow
I-12	MER 528	Salt Slough Ditch @ Hereford Road	Inflow
T-1	MER 510	CCID Main @ Russell Ave.	Internal Flow
T-5	MER 519	Santa Fe Canal @ Henry Miller Road	Internal Flow
T-7A	MER 543	San Luis Canal @ Henry Miller Road	Internal Flow
T-7	MER 527	San Luis Canal @ Highway 152	Internal Flow
T-13	MER 548	Porter-Blake Bypass	Internal Flow
T-14	MER 537	San Luis Spillway Ditch @ Santa Fe Grade	Internal Flow
O-1	MER 551	Mud Slough (N) @ Newman Gun Club	Outflow
O-2A	MER 542	Mud Slough (N) @ San Luis Drain	Outflow
O-3	MER 554	Los Banos Creek @ Highway 140	Outflow
O-4	MER 531	Salt Slough @ Lander Avenue	Outflow

Figure 2

Grassland Area of Western Merced County

MONITORING SITES



recoveries. Reported results fall within quality assurance tolerance guidelines outlined in Table 2.

TABLE 2

Quality Assurance Tolerance Guidelines

Constituent	Recovery Range at Low Levels (mg/L)*	Acceptable Blind Duplicate Spike Recovery Range
Copper	1-20 +/- 5	> 20 70-130%
Chromium	1-20 +/- 5	> 20 70-130%
Lead	5-25 +/- 8	> 25 60-140%
Molybdenum	1	90-110%
Nickel	5-25 +/- 6	>25 65-135%
Selenium	0.2	90-110%
Zinc	1-20 +/- 6	> 20 70-130%
Boron	50	85-115%
Chloride	5000	85-115%

* For certain constituents, recovery is expressed as an absolute value rather than a percentage at low levels. For example, if the result of copper analysis for a particular sample is 10 μg/L, a duplicate analysis must fall between 5 μg/L and 15 μg/L. If the sample is greater than 20 μg/L, recovery is expressed as a percent and must be between 70 and 130%. If a recovery range is not shown at low levels, the detection limit is given.

Load Calculations

The loads and flow weighted concentrations were calculated and combined for selenium, boron and salt for Mud Slough (north) and Salt Slough as well as for all the inflow drains. Loads for selenium and boron were calculated in pounds and salt was calculated in tons. The flow weighted concentrations for salt and boron were calculated in units of mg/L and selenium was calculated in units of μg/L. The drains used in the load calculations were the following: Firebaugh Main Drain (includes Broadview WD, CCID, Firebaugh WD), Panoche Drain, Charleston Drain and Hamburg Drain (Pacheco WD). The total load from the drains were the summation of Main, Panoche, Charleston, and Hamburg drain loads minus the drainage water mixed with CCID supply water. A portion of the drain water mixed into CCID's supply canal (which is not sampled) is also routed to the Camp 13 ditch (which is sampled); therefore, when the drain water is mixed into CCID's supply canal then its quality can be assumed to be the same as the drain water in Camp 13 ditch.

Detailed methodologies for the load calculations can be found in Karkoski and Tucker, 1993, and Karkoski, 1994.

RESULTS

Following the trend found in other WYs, the highest concentrations of the measured constituents were found at the inflow monitoring stations near the southern boundary of the Grassland Area. The internal flow stations which carried supply water had the lowest measured constituent concentrations. Constituent concentrations at outflow monitoring stations varied depending on whether the channel was carrying subsurface drainage from the Drainage Study Area (DSA). Water quality analysis results at the inflow, internal flow, and outflow monitoring stations will be discussed separately.

Water quality results for both minerals and trace elements are listed by site in Appendices A through C; Grassland inflows (Appendix A), internal flows (Appendix B), and outflows (Appendix C). The ranges, mean and median values for each measured constituent at each site are also shown in these appendices. For this study, EC represented relative salinity; while boron, chloride, and sulfate were the primary mineral constituents of concern. Selenium and molybdenum were the primary trace elements of concern. The median mineral, trace element and hardness values for WY 94 are listed in Table 3 for each monitoring station. The median and trace element values are tabulated for WY 94 and previous water years in Table 4.

<u>Minerals</u>

Inflow Monitoring Stations:

The inflow monitoring stations represent the quality of the agricultural drainage entering the Grassland Area. The first eight monitoring stations (I-1, I-2, I-4, I-6 to I-10) listed in Table 1 represent inflow into the South Grassland Area. The remaining two inflow stations (I-11 and I-12) either discharge to sloughs or the North Grassland Area (Figure 2).

Continuing the trend found in previous WYs, the inflows that carry a substantial portion of subsurface drainage water, Main (Firebaugh) (I-1), Panoche (I-2), Hamburg (I-6), and Charleston Drains (I-8), had elevated salinity levels. Hamburg Drain had the highest median EC (5,320 μmhos/cm), chloride (742 mg/L), hardness (1,660 mg/L) and sulfate (1,650 mg/L) values. Panoche Drain had the highest median boron (8.0 mg/L) value.

Table 3. **Median Constituent Concentrations for Waterways throughout the Grassland Watershed: WY94**

Type	Station	EC (umhos/cm)	B	Cl	SO4	Se	Mo	Cr	Cu	Ni	Pb	Zn	Hardness
			mg/L			ug/L							mg/L
I	Main (Firebaugh) Drain	3550	4.49	455	1235	61	29	24	12	33	<5	26	889
I	Panoche Drain	4840	7.95	624	1320	88	10	38	7	16	<5	8	1120
I	Agatha Canal	3570	5.93	468	1070	14	13	—	6	—	—	—	808
I	Hamburg Drain	5320	5.88	742	1650	88	7	20	7	15	<5	6	1655
I	Camp 13	3960	5.78	512	1275	58	12	—	8	—	—	—	866
I	Charleston Drain	4540	3.98	582	1400	78	6	12	8	12	<5	15	1200
I	Almond Drain	840	0.58	106	116	2.1	—	—	—	—	—	—	180
I	Rice Drain	2970	5.35	352	866	3.2	17	—	—	—	—	—	674
I	Boundary Drain	1670	0.65	301	223	1.1	—	—	—	—	—	—	327
I	Salt Slough @ Hereford	1020	0.33	168	138	0.8	—	—	7	—	—	—	216
T	San Luis Spillway	820	0.52	132	110	0.6	—	—	7	—	—	—	170
T	CCID Main Canal	670	0.37	92	102	1.7	—	—	6	—	—	—	142
T	Santa Fe Canal @ Henry Miller Rd.	900	0.63	135	174	1.8	—	—	—	—	—	—	221
T	San Luis Canal @ Henry Miller Rd.	980	0.8	130	184	2.5	—	—	—	—	—	—	222
T	San Luis Spillway Ditch @ Santa Fe Grade	820	0.52	132	110	0.6	—	—	7	—	—	—	170
T	Porter-Blake Bypass	3160	4.9	400	897	44	—	—	—	—	—	—	700
O	Salt Slough @ Lander	2510	2.5	395	578	20	9	10	7	11	<5	11	410
O	Mud Slough @ Newman Gun Club	1610	1.21	230	260	1.1	—	6	4	7	<5	7	319
O	Los Banos Creek	1530	0.91	228	200	0.6	—	—	—	—	—	—	295
O	Mud Slough @ San Luis Drain	2560	1.94	526	732	1.0	9	7	4	8	<5	5	420

* Site only sampled during November 1992

I = Inflow
T = Internal flow
O = Outflow
SLD = San Luis Drain site

Table 4

Median Constituent Concentrations for Grassland Area Canals & Streams: Water Years 1985-1994.

(Data for WY's 85, 86, and 87 from James et al., 1988; for WY 88 from Chilcott et. al., 1989; for WY's 89, 90, and 91 from Westcot et al., 1990, 1991,1992; for WY92 from Karkoski and Tucker 1993 and for WY93 Chilcott et.al. 1995).

Map ID	Monitoring Site / Water Year	EC umhos/cm	B (mg/L)	Cl (mg/L)	SO4 (mg/L)	Se (ug/L)	Mo (ug/L)	Cr (ug/L)	Cu (ug/L)	Ni (ug/L)	Pb (ug/L)	Zn (ug/L)	Hardness mg/L
I-1	Main (Firebaugh) Drain @ Russell												
	Dry WY 85	2400	3.2	230	693	35	--	--	--	--	--	--	--
	Wet WY 86	2700	3.5	250	900	46	14	16	9	27	--	14	--
	Critical WY 87	2600	3.4	270	630	42	9	19	9	22	--	28	--
	Critical WY 88	3000	3.6	320	790	49	10	22	12	22	<5	29	--
	Critical WY 89	2980	3.9	315	835	49	13	17	9	19	<5	23	--
	Critical WY 90	3400	4.6	370	1200	52	24	10	5	11	<5	13	--
	Critical WY 91	3450	4.6	440	1400	52	21	10	23	<5	21	18	940
	Critical WY 92	3700	5.2	319	849	59	28	14	8	17	<5	18	640
	Above Normal WY 93	3530	5.1	342	972	52	19	27	14	24	<5	34	834
	Critical WY 94	3550	4.5	455	1235	61	29	24	12	33	<5	26	889
I-2	Panoche Drain/O'Banion												
	Dry WY 85	3500	6.5	460	985	38	3	--	--	--	--	--	--
	Wet WY 86	3400	5.8	390	800	56	6	26	6	15	--	15	--
	Critical WY 87	4375	7.8	550	1075	47	3	40	10	13	--	18	--
	Critical WY 88	3650	6.4	440	890	54	3	43	12	21	<5	29	--
	Critical WY 89	4180	6.5	520	1000	69	6	32	5	8	<5	11	--
	Critical WY 90	4550	7.5	665	1400	72	8	32	4	9	<5	10	--
	Critical WY 91	4450	7.5	620	1300	64	8	3	20	<5	7	7	1200
	Critical WY 92	4870	8.0	655	1490	82	11	16	3	<5	<5	6	1200
	Above Normal WY 93	4800	7.7	620	1280	76	11	38	10	15	<5	11	1170
	Critical WY 94	4840	8.0	624	1320	88	10	38	7	16	<5	8	1124
I-4	Agatha Canal												
	Dry WY 85	2600	4.9	315	1100	26	1	--	--	--	--	--	--
	Wet WY 86	3300	5.6	400	900	44	<5	13	9	21	--	16	--
	Critical WY 87	3305	5.6	410	760	38	6	22	7	12	--	12	--
	Critical WY 88	3550	5.6	430	895	39	3	--	--	--	--	--	--
	Critical WY 89	880	0.36	130	100	2.9	2	--	--	--	--	--	--
	Critical WY 90	4040	6.6	480	1100	26	8	--	--	--	--	--	--
	Critical WY 91	4295	6.6	515	1100	53	9	--	--	--	--	--	1030
	Critical WY 92	3440	5.6	378	726	31	9	--	--	--	--	--	619
	Above Normal WY 93	3165	5.4	426	1045	23	8	--	11	--	--	--	855
	Critical WY 94	3570	5.9	468	1070	14	13	--	6	--	--	--	808
I-6	Hamburg Drain												
	Dry WY 85	3200	3.8	435	900	47	6	--	--	--	--	--	--
	Wet WY 86	3250	4.0	400	1000	51	4	13	5	10	--	13	--
	Critical WY 87	3345	3.7	420	925	58	<5	17	5	8	--	10	--
	Critical WY 88	3600	4.1	450	1050	56	5	11	5	<5	<5	6	--
	Critical WY 89	5120	5.7	660	1500	95	5	16	2	<5	<5	6	--
	Critical WY 90	4740	5.4	720	1400	84	5	14	1	<5	<5	6	--
	Critical WY 91	5540	5.6	730	1675	99	7	1	11	1	<5	<5	1650
	Critical WY 92	5090	5.2	725	1580	86	9	20	9	13	<5	18	1650
	Above Normal WY 93	5020	6.3	723	1515	76	9	25	7	13	<5	23	1630
	Critical WY 94	5320	5.9	742	1650	88	7	20	7	15	<5	6	1655

* Only sampled during November 1992

Table 4 continued:

Map ID	Monitoring Site / Water Year	Median Constituent Concentrations EC umhos/cm	B (mg/L)	Cl (mg/L)	SO4 (mg/L)	Se (ug/L)	Mo (ug/L)	Cr (ug/L)	Cu (ug/L)	Ni (ug/L)	Pb (ug/L)	Zn (ug/L)	Hardness (mg/L)
I-7	Camp 13 Slough												
	Dry WY 85	2550	3.4	280	745	32	4	--	--	--	--	--	--
	Wet WY 86	2950	3.9	375	905	43	<5	14	7	20	--	16	--
	Critical WY 87	2650	3.7	280	590	43	6	30	11	13	--	19	--
	Critical WY 88	4400	6.2	500	1050	43	4	--	--	--	--	--	--
	Critical WY 89	3750	5.2	440	940	59	8	--	--	--	--	--	--
	Critical WY 90	3440	4.9	455	1010	54	9	--	--	--	--	--	--
	Critical WY 91	3960	5.5	560	1300	55	21	--	--	--	--	--	1200
	Critical WY 92	4130	5.5	492	1240	64	11	--	--	--	--	--	1100
	Above Normal WY 93	4020	6.2	414	997	56	10	--	11	--	--	--	939
	Critical WY 94	3960	5.8	513	1275	58	12	5	8	13	<5	6	866
I-8	Charleston Drain												
	Dry WY 85	3900	2.6	395	1275	48	--	--	--	--	--	--	--
	Wet WY 86	4500	4.7	510	1580	93	8	9	10	14	--	18	--
	Critical WY 87	3855	4.2	480	1035	79	2	32	12	22	--	50	--
	Critical WY 88	4450	4.5	520	1300	71	3	31	13	27	--	47	--
	Critical WY 89	4400	3.8	520	1400	66	3	25	12	17	<5	33	--
	Critical WY 90	4350	3.7	525	1400	69	6	14	3	8	<5	17	--
	Critical WY 91	4370	4.2	645	1700	60	8	3	10	<5	7	11	1600
	Critical WY 92	4283	4.3	609	1300	66	8	10	7	9	<5	21	1310
	Above Normal WY 93	4155	4.2	685	1450	70	8	15	7	14	<5	20	1590
	Critical WY 94	4540	4.0	582	1400	78	6	12	8	12	<5	15	1200
I-9	Almond Drive Drain												
	Dry WY 85	1520	1.6	160	340	2.0	--	--	--	--	--	--	--
	Wet WY 86	--	--	--	--	--	--	--	--	--	--	--	--
	Critical WY 87	1925	2.1	224	395	4.8	5	28	11	21	--	25	--
	Critical WY 88	2300	2.1	230	460	4.6	--	18	7	13	--	15	--
	Critical WY 89	2160	2.2	190	420	3.7	--	--	--	--	--	--	--
	Critical WY 90	1320	0.91	155	220	2.3	--	--	--	--	--	--	--
	Critical WY 91	1415	1	200	250	2.9	--	--	--	--	--	--	330
	Critical WY 92	1670	1.5	220	320	2.2	--	--	--	--	--	--	330
	Above Normal WY 93	900	0.40	123	119	1.9	9	--	--	--	--	--	187
	Critical WY 94	840	0.58	106	116	2.1	--	--	--	--	--	--	180
I-10	Rice Drain												
	Dry WY 85	2450	5.7	245	715	2.5	--	--	--	--	--	--	--
	Wet WY 86	3300	8.1	350	1080	3.0	14	5	6	23	--	13	--
	Critical WY 87	2500	6.1	260	550	2.6	11	3	3	6	--	<1	--
	Critical WY 88	2790	5.1	310	700	2.6	15	--	--	--	--	--	--
	Critical WY 89	2745	5.4	280	673	3.1	14	--	--	--	--	--	--
	Critical WY 90	3050	5.4	350	855	2.7	16	--	--	--	--	--	--
	Critical WY 91	2640	4.7	420	1145	2.6	22	--	--	--	--	--	860
	Critical WY 92	3000	5.9	400	868	3.4	20	--	--	--	--	--	700
	Above Normal WY 93	2250	4.1	240	617	2.6	12	--	--	--	--	--	525
	Critical WY 94	2970	5.4	352	866	3.2	17	--	--	--	--	--	674
I-11	Boundary Drain												
	Dry WY 85	1090	0.45	195	135	1.0	--	--	--	--	--	--	--
	Wet WY 86	1710	0.65	250	210	1.0	6	2	7	9	--	14	--
	Critical WY 87	1250	0.54	200	145	1.6	4	<1	2	<5	--	3	--
	Critical WY 88	1470	0.50	230	180	1.4	6	--	--	--	--	--	--
	Critical WY 89	1435	0.53	240	190	1.0	--	--	--	--	--	--	--
	Critical WY 90	1500	0.44	250	175	0.9	--	--	--	--	--	--	--
	Critical WY 91	1420	0.44	233	175	0.8	--	--	--	--	--	--	280
	Critical WY 92	1330	0.48	237	164	0.8	--	--	--	--	--	--	290
	Above Normal WY 93	1040	0.49	177	126	1.1	--	--	--	--	--	--	232
	Critical WY 94	1660	0.65	301	223	1.1	--	--	--	--	--	--	327

Table 4 continued:

Map ID	Monitoring Site / Water Year	EC umhos/cm	B	Cl	SO4	Se	Mo	Cr	Cu	Ni	Pb	Zn	Hardness
			Median Constituent Concentrations										
			----------mg/L----------			----------ug/L----------							----mg/L----
I-12	Salt Slough @ Hereford												
	Dry WY 85	850	0.37	120	100	1.0	--	--	--	--	--	--	--
	Wet WY 86	785	0.33	100	99	1.0	<5	3	5	9	--	22	--
	Critical WY 87	1000	0.39	130	120	1.4	3	1	2	<5	--	2	--
	Critical WY 88	1150	0.38	160	140	1.2	5	--	--	--	--	--	--
	Critical WY 89	1070	0.36	160	140	1.2	--	--	--	--	--	--	--
	Critical WY 90	1030	0.30	160	110	0.6	--	--	--	--	--	--	--
	Critical WY 91	1045	0.30	180	130	0.9	--	--	--	--	--	--	260
	Critical WY 92	1140	0.37	180	125	1.0	--	--	--	--	--	--	285
	Above Normal WY 93	1060	0.35	149	120	0.8	--	--	6	--	--	--	214
	Critical WY 94	1020	0.33	168	138	0.8	--	--	7	--	--	--	216
T-1	CCID Main Canal												
	Dry WY 85	430	0.21	72	35	<1	--	--	--	--	--	--	--
	Wet WY 86	385	0.21	53	47	1.3	<5	3	3	5	--	8	--
	Critical WY 87	570	0.28	65	58	2.2	<5	1	3	<5	--	3	--
	Critical WY 88	760	0.29	120	65	1.7	--	--	--	--	--	--	--
	Critical WY 89	700	0.26	94	68	1.7	--	--	--	--	--	--	--
	Critical WY 90	680	0.32	120	93	2.3	--	--	--	--	--	--	--
	Critical WY 91	710	0.27	135	86	1.5	--	--	--	--	--	--	150
	Critical WY 92	800	0.38	130	110	2.0	--	--	--	--	--	--	170
	Above Normal WY 93	820	0.35	77	83	1.4	--	--	11	--	--	--	155
	Critical WY 94	670	0.37	92	102	1.7	--	--	6	--	--	--	142
T-5	Santa Fe Canal @ Henry Miller Road												
	Above Normal WY 93	1208	1.2	150	171	5.3	4	--	--	--	--	--	288
	Critical WY 94	900	0.63	135	174	1.8	--	--	--	--	--	--	221
T-7	San Luis Canal/Hwy 152												
	Dry WY 85	1550	1.4	180	295	4.5	--	--	--	--	--	--	--
	Wet WY 86	1200	1.4	130	200	2.0	<5	4	4	10	--	9	--
	Critical WY 87	2630	3.4	260	520	4.0	<5	3	3	<5	--	7	--
	Critical WY 88	2550	3.6	280	570	3.9	--	--	--	--	<5	--	--
	Critical WY 89	1045	0.76	135	140	2.5	--	--	--	--	--	--	--
	Critical WY 90	1400	1.7	180	270	2.5	--	--	--	--	--	--	--
	Critical WY 91	1625	1.6	260	455	2.6	--	--	--	--	--	--	520
	Critical WY 92	1030	0.60	170	240	1.7	--	--	--	--	--	--	270
	Above Normal WY 93	878	0.53	134	116	2.1	--	--	--	--	--	--	209
	Critical WY 94	935	0.62	118	131	1.7	--	--	--	--	--	--	191
T-7A	San Luis Canal @ Henry Miller Road												
	Above Normal WY 93	1730	2.2	198	345	12	--	--	--	--	--	--	402
	Critical WY 94	980	0.8	130	184	2.5	--	--	--	--	--	--	222
T-13	Porter Blake Bypass												
	Above Normal WY 93	3360	5.2	351	832	46	--	--	--	--	--	--	777
	Critical WY 94	3160	4.9	400	897	44	--	--	--	--	--	--	700
T-14	San Luis Spillway Ditch @ Santa Fe Grade												
	Above Normal WY 93	778	0.37	155	80.4	0.3	--	--	5	--	--	--	216
	Critical WY 94	820	0.52	132	110	0.6	--	--	7	--	--	--	170

Table 4 continued:

Map ID	Monitoring Site / Water Year	EC	B	Cl	SO4	Se	Mo	Cr	Cu	Ni	Pb	Zn	Hardness
		Median Constituent Concentrations											
		umhos/cm	----------mg/L----------			----------------------------------ug/L----------------------------------							-----mg/L-----
O-1	Mud Slough @ NGC												
	Dry WY 85	-	--	--	--	--	--	--	--	--	--	--	--
	Wet WY 86	1800	2.0	215	330	4.0	5	9	5	11	--	15	--
	Critical WY 87	2600	2.4	300	420	5.1	13	7	4	10	--	1	--
	Critical WY 88	2480	2.2	330	440	4.7	--	--	--	--	--	--	--
	Critical WY 89	2310	1.7	325	385	2.1	--	--	--	--	--	--	--
	Critical WY 90	2480	2.1	335	510	4.3	10	--	--	--	--	--	--
	Critical WY 91	3540	3.2	540	905	3.9	15	--	--	--	--	--	780
	Critical WY 92	3130	2.6	450	663	2.3	--	--	--	--	--	--	605
	Above Normal WY 93	1980	1.5	382	558	3.0	9	6	2	<5	<5	4	509
	Critical WY 94	1605	1.2	230	260	1.1	--	6	4	7	<5	7	319
O-2A	Mud Slough @ SLD												
	Dry WY 85	2600	3.1	305	525	13	--	--	--	--	--	--	--
	Wet WY 86	2300	3.0	280	630	8.5	8	6	5	14	--	11	--
	Critical WY 87	2600	3.0	320	540	17	9	12	9	11	--	7	--
	Critical WY 88	2820	2.7	350	510	9.3	11	--	--	--	--	--	--
	Critical WY 89	3000	2.4	425	480	2.1	11	10	4	<5	12	12	--
	Critical WY 90	3060	3.4	410	590	5.2	12	6	2	8	<5	7	--
	Critical WY 91	4030	4.4	640	1000	2.4	27	3	5	<5	6	5	820
	Critical WY 92	3130	2.5	460	660	1.5	22	6	4	10	<5	8	630
	Above Normal WY 93	2495	1.9	343	491	2.0	9	12	5	10	<5	9	454
	Critical WY 94	2560	1.9	526	732	1.0	9	7	4	8	<5	5	420
O-3	Los Banos Ck/HWY 140												
	Dry WY 85	--	--	--	--	--	--	--	--	--	--	--	--
	Wet WY 86	2200	2.3	430	300	1.0	<5	6	8	18	--	17	--
	Critical WY 87	1855	1.6	215	215	1.4	--	--	--	--	--	--	--
	Critical WY 88	1690	1.2	230	210	1.1	--	--	--	--	--	--	--
	Critical WY 89	1630	1.0	240	200	0.9	--	--	--	--	--	--	--
	Critical WY 90	1870	1.2	210	290	0.8	--	--	--	--	--	--	--
	Critical WY 91	2745	1.6	490	495	1.0	14	--	--	--	--	--	605
	Critical WY 92	1500	1.4	--	--	1.1	--	--	--	--	--	--	400
	Above Normal WY 93	1478	1.3	182	193	1.0	--	--	--	--	--	--	280
	Critical WY 94	1530	0.91	228	200	0.6	--	--	--	--	--	--	295
O-4	Salt Slough @ Lander												
	Dry WY 85	1250	0.96	185	195	4.5	--	--	--	--	--	--	--
	Wet WY 86	1610	1.3	240	245	7.4	7	4	6	12	--	18	--
	Critical WY 87	1720	1.7	250	350	12	6	6	4	6	--	4	--
	Critical WY 88	1940	1.9	260	385	13	6	--	--	--	--	--	--
	Critical WY 89	2040	1.9	270	430	15	6	13	6	1	12	18	--
	Critical WY 90	2340	2.3	340	525	15	7	10	4	9	<5	15	--
	Critical WY 91	2460	2.0	335	370	15	11	2	3	<5	<5	5	460
	Critical WY 92	2420	2.1	400	445	13	11	6	3	8	<5	8	590
	Above Normal WY 93	2270	2.5	327	385	18	9	13	6	11	<5	13	470
	Critical WY 94	2510	2.5	395	578	20	9	10	7	11	<5	11	410

Internal Flow Monitoring Stations:

Two internal flow sites (the San Luis Spillway and the CCID Main) were monitored weekly during the fall wetland flooding period and monthly thereafter in WY 94. These channels are the major sources of supply water for duck hunting clubs. Salinity and boron concentrations remained relatively low in the channels. Median EC was 820 and 670 μmhos/cm for the Spillway and CCID Main, respectively, while median boron concentrations were 0.52 and 0.37 mg/L, respectively.

Outflow Monitoring Stations:

All of the outflow sites had elevated levels of salinity and minerals (Table 3). Mud Slough (north) at the San Luis Drain (0-2A) and Salt Slough at Lander (0-4) are both located near continuous flow meters making them valuable stations to determine constituent loads leaving the Grasslands Area.

During WY 94, Mud Slough (north) near the San Luis Drain had EC values ranging from 850 to 5,650 μmhos/cm with a median of 2,560 μmhos/cm. Boron at this site ranged from 0.06 to 4.4 mg/L with a median value of 1.9 mg/L.

Salt Slough had EC values ranging from 1,040 to 3,740 μmhos/cm with a median value of 2,510 μmhos/cm. Boron concentrations at Salt Slough ranged from 0.64 to 4.7 mg/L with a median of 2.5 mg/L.

All available mineral information for the outflow sites during WY 94 has been tabulated in Appendix C.

Trace Elements

Although selenium was monitored at every site and molybdenum at most sites, analyses of additional trace elements were limited based on the overall low concentrations found by James, et al. (1988). Total recoverable selenium, molybdenum, copper, chromium, lead, nickel, and zinc are listed in Appendices A through C for inflow, internal flow, and outflow monitoring stations, respectively. The ranges, mean and median concentrations for the trace elements measured at each station are also listed in these appendices. The median trace element concentrations at each station for WY 94 are tabulated in Table 3.

Inflow Monitoring Stations:

The highest median trace element concentrations occurred at the South Grassland inflow stations (I-1, I-2, I-4, and I-6 to I-10), where the median selenium values ranged from 2.1 μg/L at Almond Drive Drain (I-9) to 88 μg/L at both Panoche Drain (I-2) and Hamburg Drain (I-6). The Main (I-l), Panoche (I-2), Hamburg (I-6), and Charleston (I-8) Drains all had high median selenium concentrations. As with salinity and boron, the concentrations vary depending on the amount of dilution by irrigation return flows and the quality of the tile water in the drain at the time of sampling. Concentrations in excess of 100 μg/L have been found at the Hamburg Drain (33% of the measurements), Panoche Drain (27% of the measurements), Main Drain (19% of the measurements), and Charleston Drain (9% of the measurements). No particular common pattern was observed in selenium distributions with respect to time, for the drains, except that the lowest concentrations occurred in the fall and elevated selenium concentrations were generally observed in the spring. There is a lull in irrigation activities in the fall and a peak in the late winter and early spring with pre-planting irrigations being applied and soils being leached for salinity control.

As has been observed in previous WYs, inflow sites that convey drainage originating from Sierra Nevada deposits (Rice Drain, Boundary Drain, and Salt Slough Ditch at Hereford Road) contain the lowest median selenium concentrations. Median selenium concentrations for these sites were less than 3.5 μg/L. Although, monitoring of molybdenum was limited, the highest median values were observed in the Main Drain (29 μg/L) and Rice Drain (17 μg/L). The remaining inflow drains had median molybdenum concentrations ranging from 6 to 12 μg/L.

In addition to selenium and molybdenum, copper, chromium, nickel, lead, and zinc were monitored at the four major subsurface drainage inflows (Main, Panoche, Hamburg and Charleston Drains). Based on the extreme hardness of the water from the inflow stations, toxicity from copper, nickel, lead, and zinc is not expected (Marshack, 1993). Median total recoverable chromium values were greater than the chronic toxicity value for hexavalent chromium (11 μg/L) during WY 94, with total chromium median values ranging from 12 to 38 μg/L. Since analyses did not include evaluation of the various chromium species, it is not known whether hexavalent chromium concentrations are high enough to cause toxicity.

Internal Flow Monitoring Stations:

The internal flow sites are monitored to track routing of subsurface drainage from irrigated lands as it moves through the Grassland conveyance system and to track the quality of water in supply channels. Elevated selenium concentrations are indicative of the presence of subsurface drainage water, as the subsurface drainage is the principal source of selenium. Elevated selenium concentrations were found almost year round in the Porter-Blake Bypass with the exception of the first two weeks in October. Concentrations ranged from 3.4 to 78 μg/L with a median of 44 μg/L. The Porter-Blake Bypass is used to route flows from the South Grassland Area to Salt Slough. Using the elevated selenium concentrations as an indicator, it appears that subsurface drainage from the DSA was continuously routed to Salt Slough during WY 94, except for the first two weeks in October.

Elevated selenium concentrations (8.2 to 57 μg/L) were found in the San Luis Canal at Henry Miller Road from late January to early March. Selenium concentration were generally below 3.5 μg/L at other times of the WY. Elevated selenium concentrations (23 to 60 μg/L) were also found in the Santa Fe Canal for a brief period in February and again in March, otherwise selenium concentrations were less than 4 μg/L. Flows from this canal can be discharged to Salt Slough via the City Gates diversion or, when the diversion is closed, flows can be routed to Mud Slough (north). Flows in excess of the Porter-Blake Bypass' capacity may also be diverted into these channels during peak flow periods such as February and March.

The San Luis Spillway Ditch and the CCID Main Canal were monitored weekly in October during part of the wetland flooding period and monthly thereafter. These channels provide supply water for the local wetlands and originate from the Delta-Mendota Canal. The maximum selenium concentration in the San Luis Spillway for WY 94 was 1.2 μg/L. In the CCID Main Canal selenium concentrations ranged from 0.4 to 3.8 μg/L; however, remained below 2 μg/L during the wetland flooding period in October. Similar concentrations of selenium were also observed in the San Luis Canal at Highway 152. This site is upstream of subsurface drainage discharges to the channel and contains water originating from the Delta-Mendota Canal.

Outflow Monitoring Stations:

The outflow monitoring stations, as mentioned earlier, are related to one of two tributaries of the San Joaquin River; the outflow through Salt Slough (site 0-4) and those that outflow through Mud Slough (north), (sites 0-1 through 0-3) as described in Table 1.

Selenium was monitored at all four outflow stations, while molybdenum, copper, chromium, nickel, lead, and zinc were monitored monthly at three stations (0-1, 0-2A and 0-4). The median trace element concentrations detected during this study are tabulated in Table 3.

At monitoring station 0-4 (Salt Slough at Lander Avenue), selenium concentrations ranged from 1.2 to 44 μg/L with a median of 20 μg/L. Selenium concentrations in Mud Slough (north) at the San Luis Drain (0-2A) ranged from 0.3 to 3.2 μg/L with a median of 1.0 μg/L. Los Banos Creek flows into Mud Slough (north) downstream of the Mud Slough (north) monitoring station near the San Luis Drain. The creek, along with any groundwater seepage, can have a diluting effect on the slough with respect to selenium, as measured at the Newman Land and Cattle Company station (0-1). Los Banos Creek receives its flow from the western portion of the North Grassland Area and from areas west of the study area. The creek receives little subsurface drainage. In WY 94, selenium concentrations range from 0.3 to 1.1 μg/L with a median of 0.6 μg/L in Los Banos Creek at Highway 140 (0-3). The downstream Mud Slough (north) station (0-1) had selenium concentrations similar to those found in the slough upstream of Los Banos Creek.

Molybdenum, copper, chromium, lead, nickel, and zinc were analyzed on a periodic basis in Salt Slough at Lander Avenue and Mud Slough (north) at the San Luis Drain. Molybdenum concentrations were the highest in Mud Slough (north), peaking at 27 μg/L with a median of

9 μg/L. All molybdenum concentrations at Salt Slough were reported at less than 15 μg/L with a median of 9 μg/L.

As is the case with the inflow stations, concentrations recorded for copper, nickel, lead, and zinc would not be expected to cause toxicity due to the elevated hardness of the water in the sloughs. Total recoverable chromium concentrations did exceed 11 μg/L (the chronic toxicity value of hexavalent chromium) in both sloughs, reaching a maximum of 27 μg/L in Mud Slough (north); however, hexavalent chromium was not measured directly.

LOADS

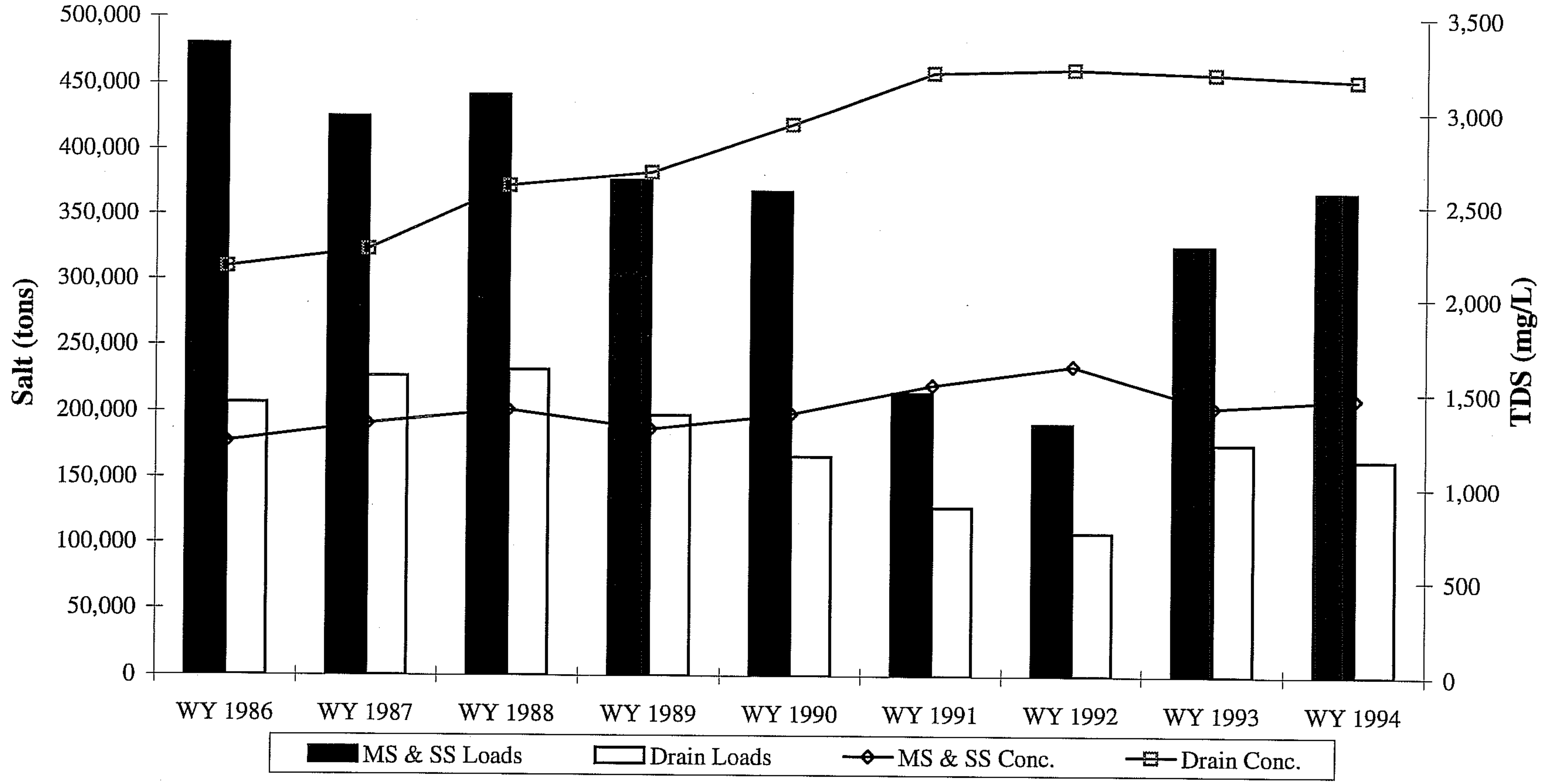
Between WYs 89 and 92, flow weighted concentrations from the drains entering the Grassland Area increased for boron, selenium and salt while the respective loads decreased (Karkoski et al, 1994). The trend toward lower loads in these drains was reversed in WY 93 (Chilcott et al., 1995). During WY 93, loads reached levels observed prior to the 1988 adoption of Basin Plan amendments to regulate subsurface drainage discharges. For WY 94, loads and flow weighted concentrations in the drains showed a similar increase to that observed between WYs 92 and 93 (Figures 3, 4, and 5). During WY 93, the first above normal runoff year after six consecutive drought years, increased federal water allotments allowed growers to leach salts accumulated during the drought period. An explanation for the elevated loads continuing in WY 94 is not readily apparent as federal water contracts were decreased to levels comparable to WY 92 when the lowest load levels were achieved.

The loads of boron and salt continue to be higher in Mud Slough (north) and Salt Slough than those from the drains; whereas, the selenium load from Mud Slough (north) and Salt Slough remains lower than those from the drains. Salt and boron is ubiquitous throughout the Grassland watershed. Selenium, in contrast, is primarily found in the subsurface drainage problem area whose drainage water is discharged into the Grassland Area. As the two major drainage arteries for the entire watershed, Mud Slough (north) and Salt Slough transport all drainage to the San Joaquin River, with most being transported through Salt Slough in WY 94. While the total salt and boron loads can be expected to be higher from the overall watershed than just the drainage problem area, the decrease in selenium loads between the discharge into the Grassland Area and the San Joaquin River (Figure 5) remains unexplained. The U.S. Bureau of Reclamation is continuing to study potential mechanisms involved in a selenium sink as discussed in Karkoski and Tucker (1993).

DISCUSSION

For the purpose of illustrating changes in water quality in Grassland Area waterways in WY 94, data for WY 94 was compared to WYs 92 and 93. WY 92 was the sixth consecutive critical runoff year and represents conditions under severe water shortages. In WY 92 exchange contractors (Firebaugh Canal W.D. and CCID) received 75% of their supply water allocations and federal contractors (Broadview W.D., Charleston D.D., Pacheco W.D., and

Figure 3
Annual Salt Loads and Concentrations for Drains and Sloughs



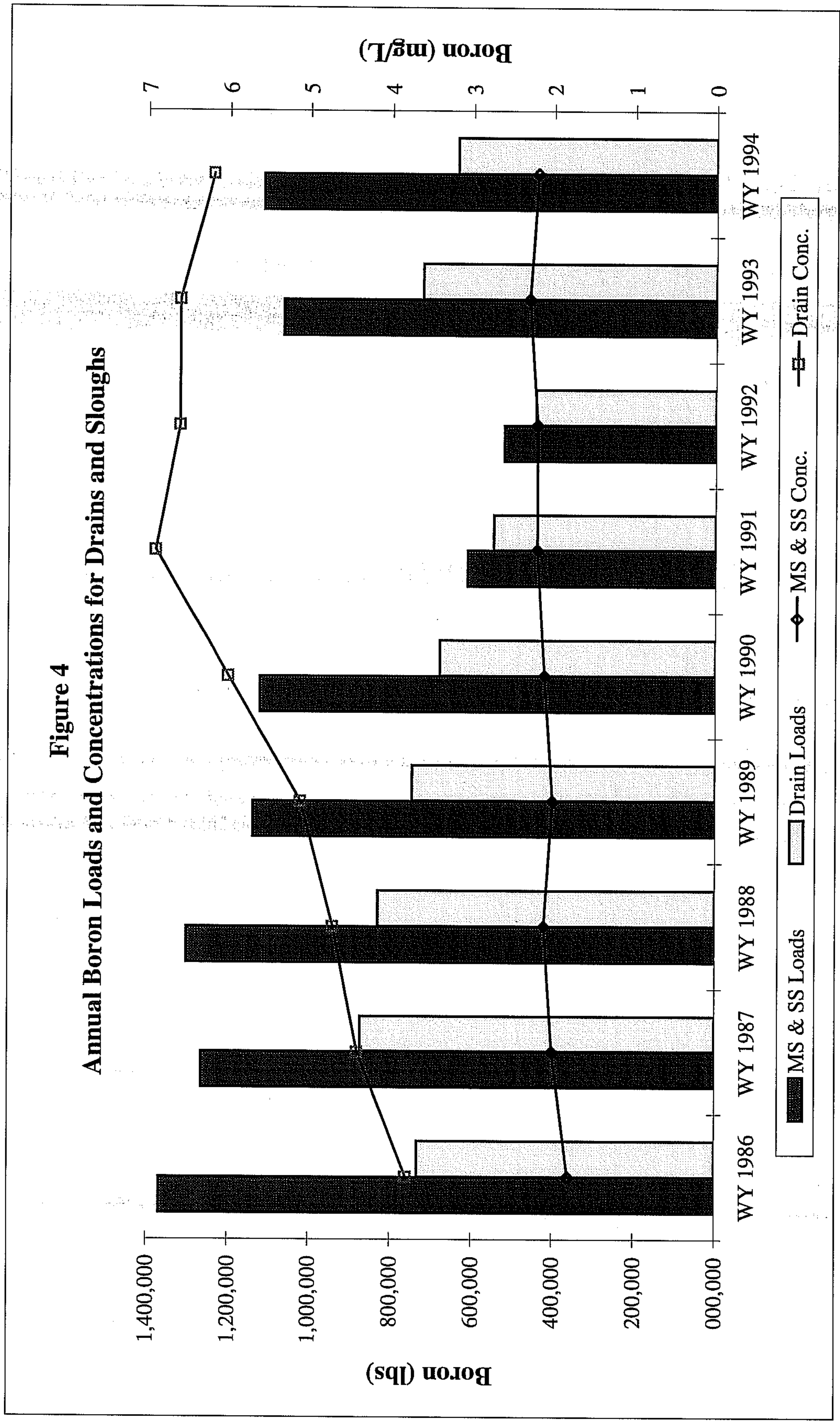


Figure 4
Annual Boron Loads and Concentrations for Drains and Sloughs
Boron (lbs)
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
000,000
Boron (mg/L)
7
6
5
4
3
2
1
0
WY 1986
WY 1987
WY 1988
WY 1989
WY 1990
WY 1991
WY 1992
WY 1993
WY 1994
MS & SS Loads
Drain Loads
MS & SS Conc.
Drain Conc.

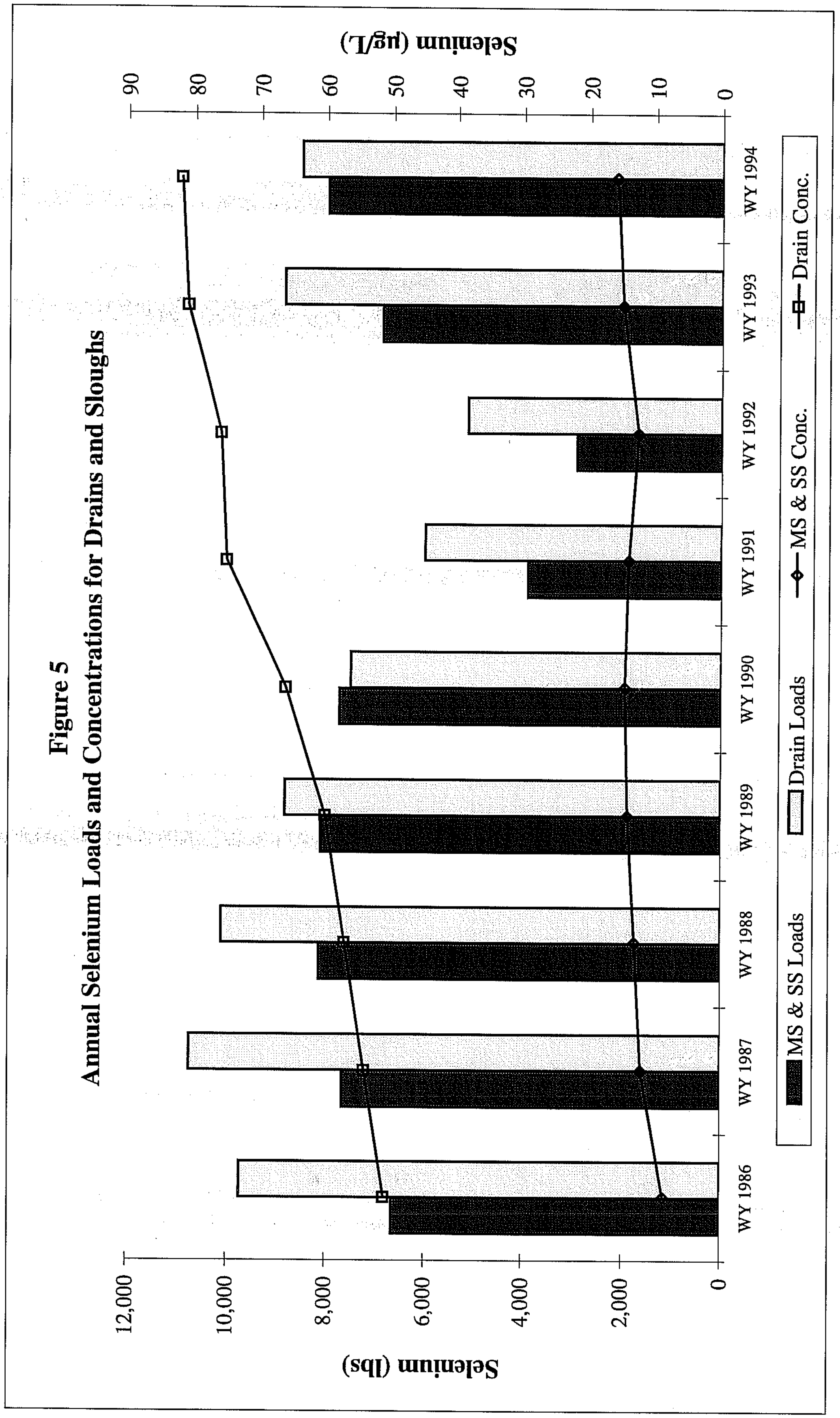


Figure 5
Annual Selenium Loads and Concentrations for Drains and Sloughs

Panoche D.D.) received 25%. WY 93 represented a respite between drought conditions as it was the first above normal runoff year after six consecutive critical water years. In WY 93 full allocations were restored to exchange contractors and federal contractors received 50% of their contract allocations. The drought resumed in WY 94 and the WY was classified as a critical runoff year. Water allocations were once again curtailed to 75% and 35% for exchange and federal contractors, respectively.

The combined effects of previously reduced water supplies with improved on-farm irrigation practices followed by near full water allocations can be seen in Figures 3-5 and Table 5. Between WYs 89[3] and 92, large reductions in loads (i.e. 41% for selenium) occurred from the drainage problem area. At the same time, concentrations of constituents of concern (salt, selenium, and boron) increased (i.e 22% for selenium) (Table 5). The increased constituent concentrations were likely due to the reduced availability of better quality tail water which reduced concentrations in the drains. This reduction in tail water results from improved irrigation management and improved water deliveries. The trend toward reduced loads of constituents of concern was reversed in WY 93 with dramatic increases in constituent loads over WY 92 (Figures 3-5). For example, there was a 75 and 63% increase in selenium and salt load, respectively, from the drainage problem area between WYs 92 and 93. This increase was attributed to improved water supplies and increased leaching of salts by Chilcott et al. (1995).

The loads from the drainage problem area in WY 94, were approximately the same as the levels for WY 93 and were 66, 44, and 52% higher for selenium, boron, and salt, respectively, when compared to WY 92 (Table 5 and Figures 3-5). This occurred in spite of the fact that WY 94 was a critical runoff year and water supplies were curtailed to exchange and federal contractors to near 1992 levels. Federal water supplies alone, however, do not account for the entire water available for crop production. Additional water supplies may have been obtained from groundwater, special purchases, and recycling of surface and subsurface drainage. Increased loads in WY 94 over WY 92 may be due to greater water usage by the drainers. Indirect evidence for increase water usage is in the combined discharge generated from the drainage problem area. There was a 54% increase in the flow in WY 94 as compared to WY 92. This flow includes both surface (tail water) and subsurface (tile water) drainage. The discharge flow, however, for WY 94 was 30% less than that generated in WY 89, although selenium loads generated were at approximately the same level as in WY 89 (Table 5).

Greater water usage in the drainage problem area in WY 94 may be evident from Figure 6. This figure depicts monthly selenium loads for Mud Slough (north) and Salt Slough combined for WYs 92, 93, and 94. Since the drainage problem area is the principal source of selenium,

[3]WY 89 was chosen as a base year, since Drainage Operation Plans and the implementation of best management practices were required by the Basin Plan beginning in calendar year 1990.

Table 5
Annual Salt, Boron and Selenium Loads, Concentrations and Flows
for the Sloughs and Drainage Service Area (DSA)
WYs- 1986-1994

Selenium Loads and Concentrations								
Water Year	MS+SS Loads lbs	DSA Loads lbs	MS+SS % Change from WY 89	DSA % Change from WY 89	MS+SS Conc. ug/L	DSA Conc. ug/L	MS+SS % Change from WY 89	DSA % Change from WY 89
WY 1986	6,638	9,722	-18%	10%	8.6	51	-39%	-15%
WY 1987	7,640	10,741	-6%	22%	12	54	-15%	-10%
WY 1988	8,130	10,097	0.4%	15%	13	57	-8%	-5%
WY 1989	8,099	8,814	0%	0%	14.1	60	0%	0%
WY 1990	7,719	7,485	-5%	-15%	14.6	66	4%	10%
WY 1991	3,899	5,992	-52%	-32%	14	75	-0.7%	25%
WY 1992	2,919	5,119	-64%	-42%	12.6	76	-11%	27%
WY 1993	6,871	8,849	-15%	0%	15	81	6%	35%
WY 1994	7,980	8,511	-1%	-3.4%	16	82	13%	37%

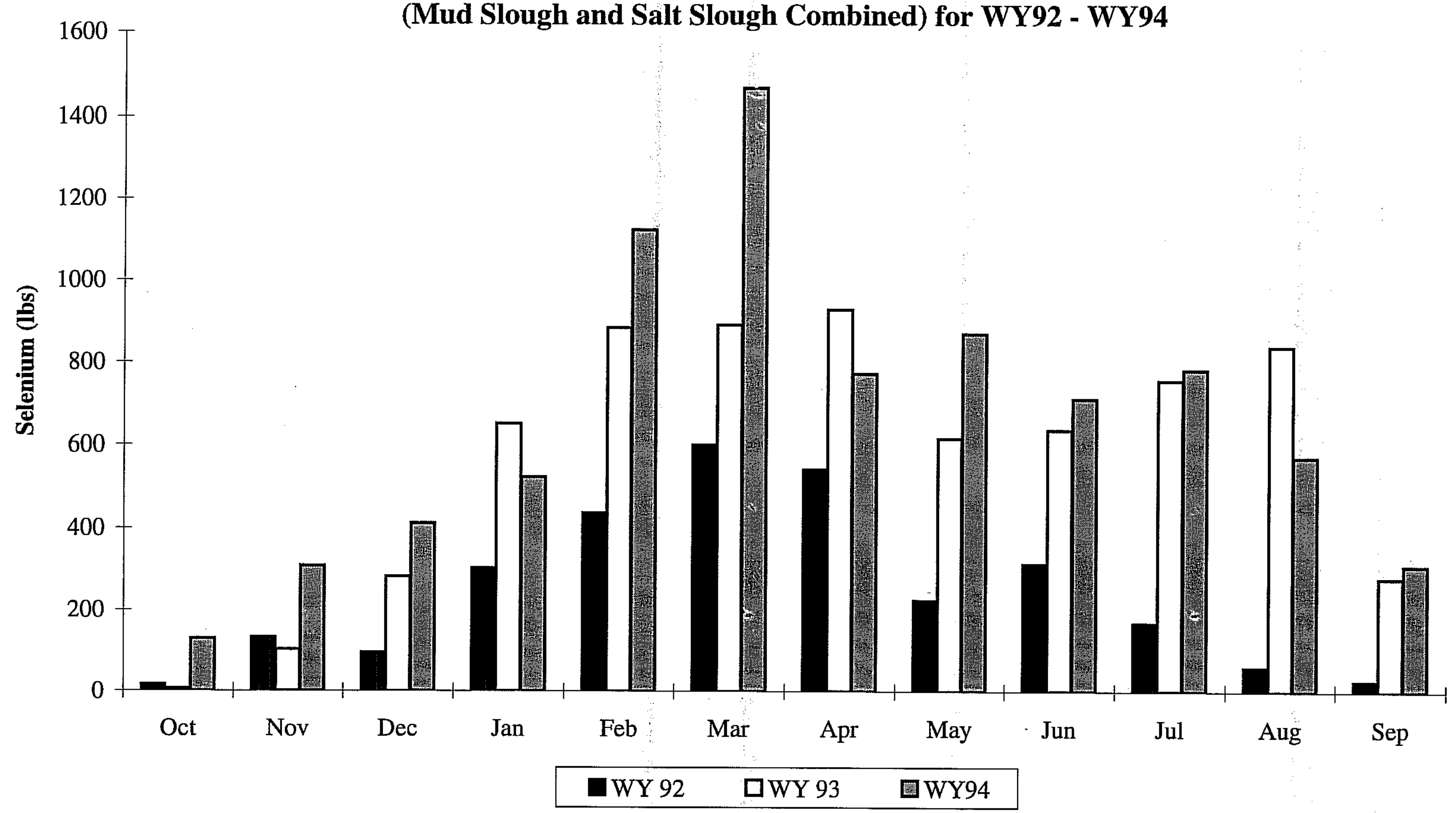
Boron Loads and Concentrations								
Water Year	MS+SS Loads lbs	DSA Loads lbs	MS+SS % Change from WY 89	DSA % Change from WY 89	MS+SS Conc. mg/L	DSA Conc. mg/L	MS+SS % Change from WY 89	DSA % Change from WY 89
WY 1986	1,368,000	733,000	20%	2%	1.8	3.8	-10%	-25%
WY 1987	1,265,000	872,000	13%	17%	2.0	4.4	0%	-14%
WY 1988	1,301,000	830,000	14%	11%	2.1	4.7	5%	-8%
WY 1989	1,139,000	748,000	0%	0%	2.0	5.1	0%	0%
WY 1990	1,121,000	680,000	-2%	-9%	2.1	6.0	5%	18%
WY 1991	612,000	548,000	-46%	-27%	2.2	6.9	10%	35%
WY 1992	522,000	443,000	-54%	-41%	2.2	6.6	10%	29%
WY 1993	1,066,000	725,000	-6%	-3%	2.3	6.6	15%	29%
WY 1994	1,116,000	638,000	-2%	-15%	2.2	6.2	10%	22%

Table 5 (con't)

Salt Loads and Concentrations								
Water Year	MS+SS Loads tons	DSA Loads tons	MS+SS % Change from WY 89	DSA % Change from WY 89	MS+SS Conc. mg/L	DSA Conc. mg/L	MS+SS % Change from WY 89	DSA % Change from WY 89
WY 1986	479,682	206,476	27%	5%	1,241	2,168	-5%	-19%
WY 1987	424,929	226,597	13%	15%	1,336	2,261	2%	-16%
WY 1988	441,079	231,348	17%	17%	1,407	2,604	7%	-3%
WY 1989	376,269	197,161	0%	0%	1,309	2,677	0%	0%
WY 1990	367,789	166,324	-2%	-15%	1,389	2,933	6%	10%
WY 1991	214,272	127,744	-43%	-35%	1,542	3,209	18%	20%
WY 1992	190,926	108,019	-49%	-45%	1,643	3,227	26%	21%
WY 1993	325,536	175,740	-13%	-11%	1,425	3,203	9%	20%
WY 1994	366,826	163,723	-3%	-17%	1,470	3,169	12%	18%

Annual Flow in acre-ft				
Water Year	MS + SS Flow (acre-ft)	Drainers Flow (acre-ft)	MS + SS % Change from WY 89	Drainers % Change from WY 89
WY 1986	284,316	70,069	34%	29%
WY 1987	233,843	73,725	11%	36%
WY 1988	230,454	65,342	9%	21%
WY 1989	211,393	54,178	0%	0%
WY 1990	194,656	41,718	-8%	-23%
WY 1991	102,162	30,039	-52%	-45%
WY 1992	85,428	24,621	-60%	-55%
WY 1993	167,955	40,359	-21%	-26%
WY 1994	183,546	37,994	-13%	-30%

Figure 6
Monthly Selenium Loads Discharged from Grasslands Watershed
(Mud Slough and Salt Slough Combined) for WY92 - WY94



this figure is a representation of the subsurface drainage generated from this area. A dramatic increase in monthly selenium loads is observed when comparing WY 94 with WY 92. Of interest are the peak loads in February and March which correspond to pre-planting irrigations and salt leaching. The selenium load levels observed in WY 94 are similar to levels observed prior to the 1988 Basin Plan amendment when heavy pre-plant and leaching irrigations also took place. The selenium loads generated between January and April, which result primarily from pre-plant irrigations, accounted for nearly 50% of the total selenium load in WY 94.

Increases of 16, 5, and 13% over WY 93 were noted in the combined selenium, boron, and salt loads for Mud Slough (north) and Salt Slough for WY 94 (Table 5 and Figures 3-5). A statistical analysis was not conducted to determine if these differences are significant. Loads at levels similar to WY 93 were not expected in Mud Slough (north) and Salt Slough combined since federal water allocations were reduced to near WY 92 levels during WY 94. At the same time, slight decreases in the loads of these constituents were observed for the drains in WY 94. The increased selenium loads in Mud Slough (north) and Salt Slough combined and the simultaneous decreases in the drains for WY 94 can not be readily explained.

Figures 7-10 show a comparison of monthly average boron and selenium concentrations for the sloughs for WYs 92 to 94. This time period was selected to note trends in concentration distributions over the past three consecutive years which were subject to varying water availabilities. The concentrations of selenium, boron, and salts were compared to the water quality objectives which were part of the Basin Plan amendment and became effective in October 1993. The applicable water quality objectives are detailed in Table 6.

TABLE 6

Water Quality Objectives for Mud Slough (north) and Salt Slough (as adopted into the Basin Plan)

Constituent	Maximum Concentration
Selenium (μg/L)	26 10 (monthly mean)
Boron (mg/L) (March 15-Sept 15)	5.8 2.0 (monthly mean)
Molybdenum (μg/L)	58 19 (monthly mean)

As was noted earlier, subsurface drainage was routed to Salt Slough in WY 94. It does not appear that the short-term overflow or diversion that was detected at the San Luis Canal at Henry Miller Road and the Santa Fe Canal made an impact on Mud Slough (north) as selenium concentrations remained well below the 10 μg/L objective throughout WY 94 (Figure 7). These low concentrations are in sharp contrast to WY 92 when the objective was exceeded

Figure 7
Monthly Mean Selenium Concentration in Mud Slough (north) near the San Luis Drain

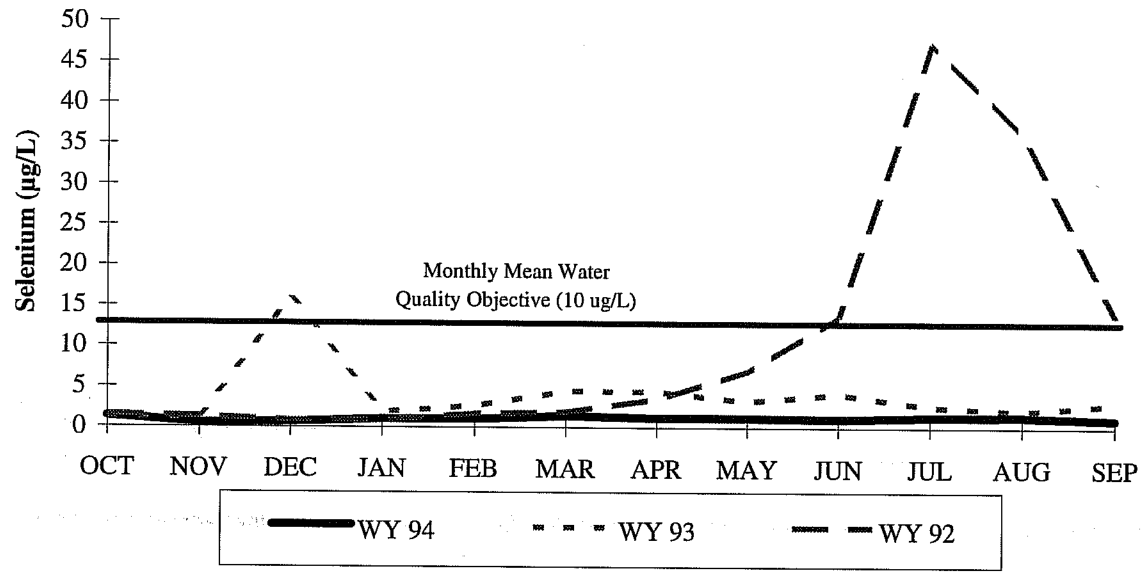
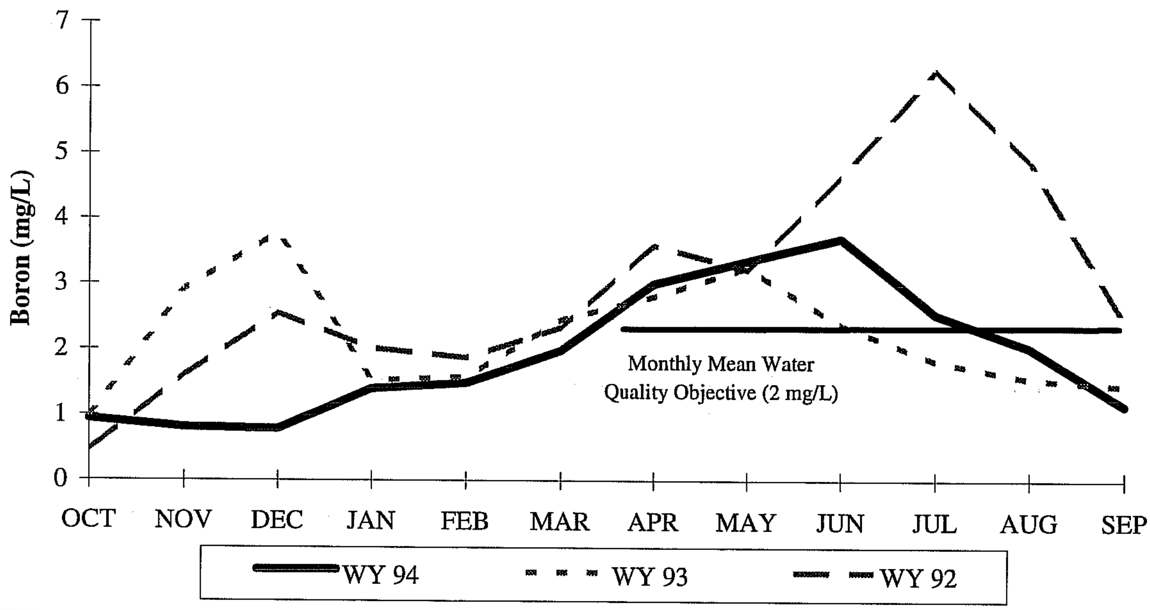


Figure 8
Monthly Mean Boron Concentrations in Mud Slough (north) near the San Luis Drain



during the summer when subsurface drainage was diverted into Mud Slough (north). Monthly mean selenium concentrations were also found to be lower in WY 94 as compared to WY 93. In addition, the maximum selenium objective (26 μg/L) was not exceeded by any of the individual measurements (Appendix C).

The seasonal (March 15 to September 15) boron objective of 2 mg/L was exceeded in Mud Slough (north) in WY 94 for the entire period when the objective applies, except for September (Figure 8). The exceedance of the objective can not be attributed to subsurface drainage flows as these were not diverted to Mud Slough (north). There is generally very little flow in the slough during this period (3.5 to 19 cfs between April and September - data in Regional Board files) and the water quality in the slough may reflect groundwater quality due to seepage. The maximum concentration objective for boron (5.8 mg/L) was not exceeded by any of the individual measurements. Maximum concentrations remained below 4.4 μg/L (Appendix C).

The selenium water quality objective of 10 μg/L was exceeded in Salt Slough in all but two months (October and November) in WY 94 (Figure 9). The exceedance of the objective is directly attributable to subsurface drainage discharges which were diverted to this slough in WY 94. The objective can be met when subsurface drainage discharges are not occurring or are low enough to be diluted by better quality flows. Selenium concentration as a function of time was atypical for WY 94. For example, selenium concentrations peaked in May rather than in February. The more typical pattern would have elevated selenium concentrations corresponding to the pre-plant irrigation in February. As demonstrated in Figure 6, peak loads did occur in February during WYs 92 and 93, as is characteristic. The elevated concentrations observed in the spring and summer may be due to less available good quality dilution flows. Good quality dilution flows result from operational spills and tail water discharges. With improved irrigation and water management due to scarce and uncertain water supplies, these two sources are being reduced.

The maximum selenium objective (26 μg/L) was exceeded in 30% of the individual measurements collected in Salt Slough during WY 94. The highest selenium concentration recorded in the slough during WY 94 was 44 μg/L (Appendix C).

The seasonal boron objective was also exceeded in Salt Slough, for the entire WY 94 period that the objective is applicable (Figure 10). The exceedance is also attributed to discharges of subsurface drainage and to less available dilution flows. The concentration distribution of boron also followed the same pattern as selenium and was atypical to previous years. All boron measurements in Salt Slough were below the maximum objective of 5.8 mg/L.

The water quality objective for molybdenum (19 μg/L) was exceeded in Mud Slough (north) in May and June (Figure 11). These interpretations are based on a single data point per month and data was not available for March. As was noted previously, flows in Mud Sough (north) were very low during this period and probably are comprised mostly of base flow. For Salt

Figure 9
Monthly Mean Selenium Concentrations in Salt Slough at Lander Avenue

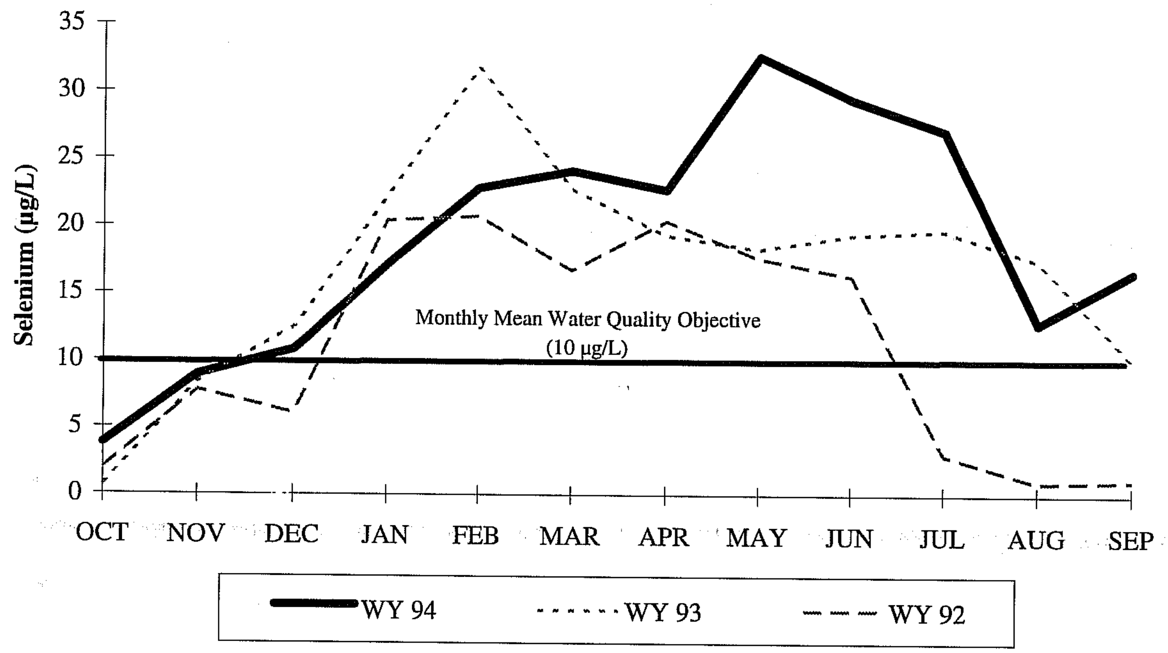


Figure 10
Monthly Mean Boron Concentration in Salt Slough at Lander Avenue

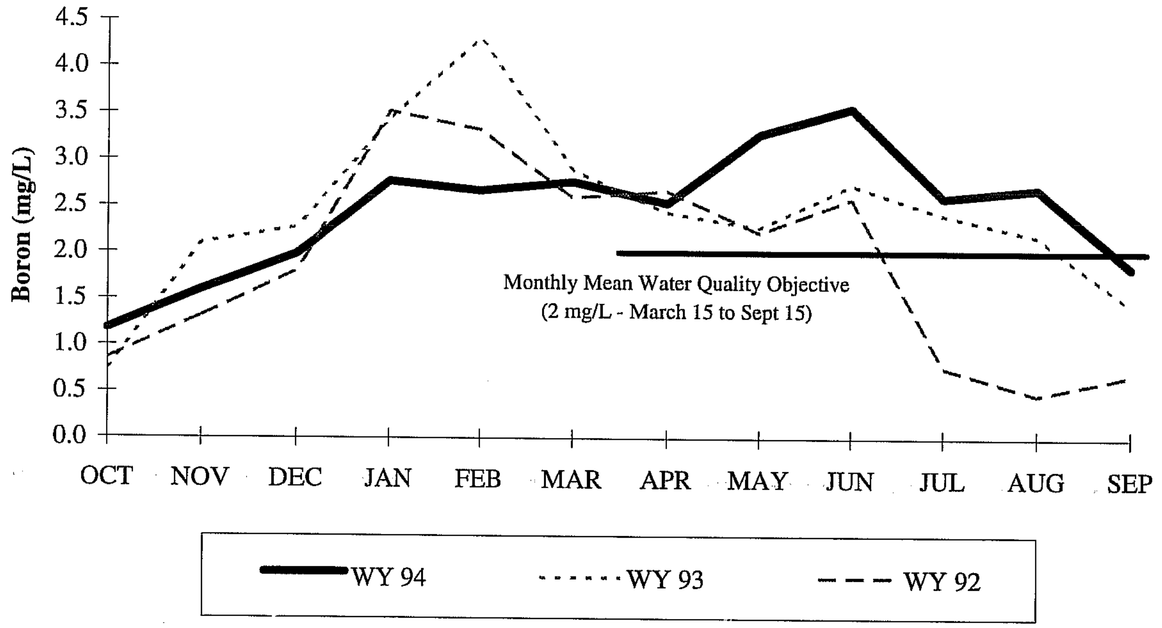


Figure 11
Monthly Mean Molybdenum Concentration in Mud Slough (north) at the San Luis Drain

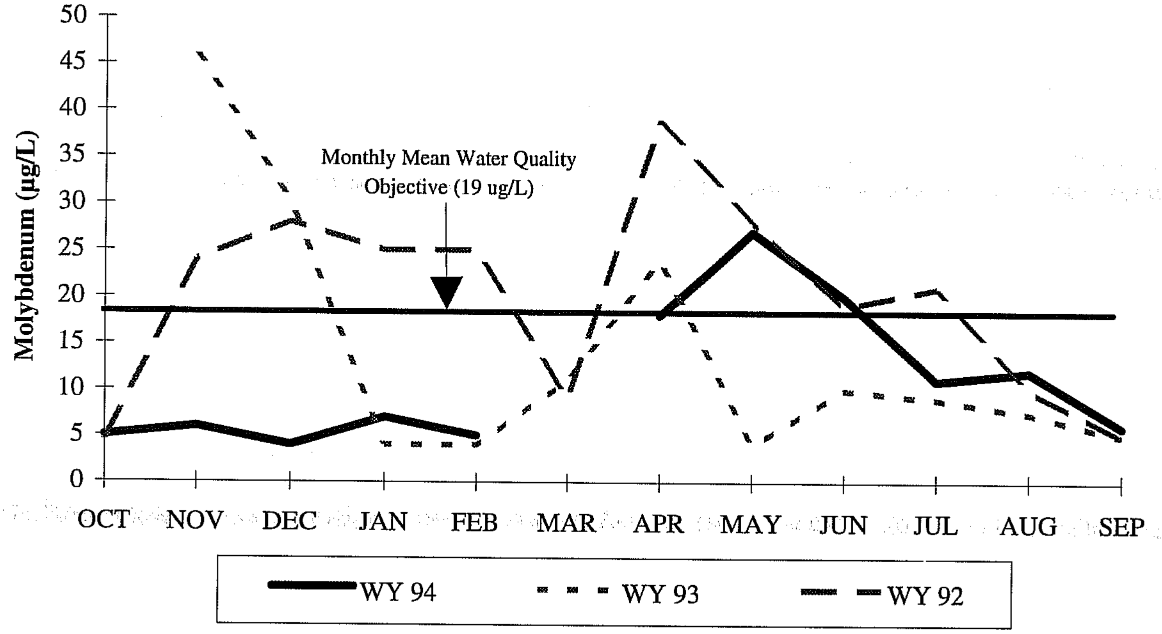
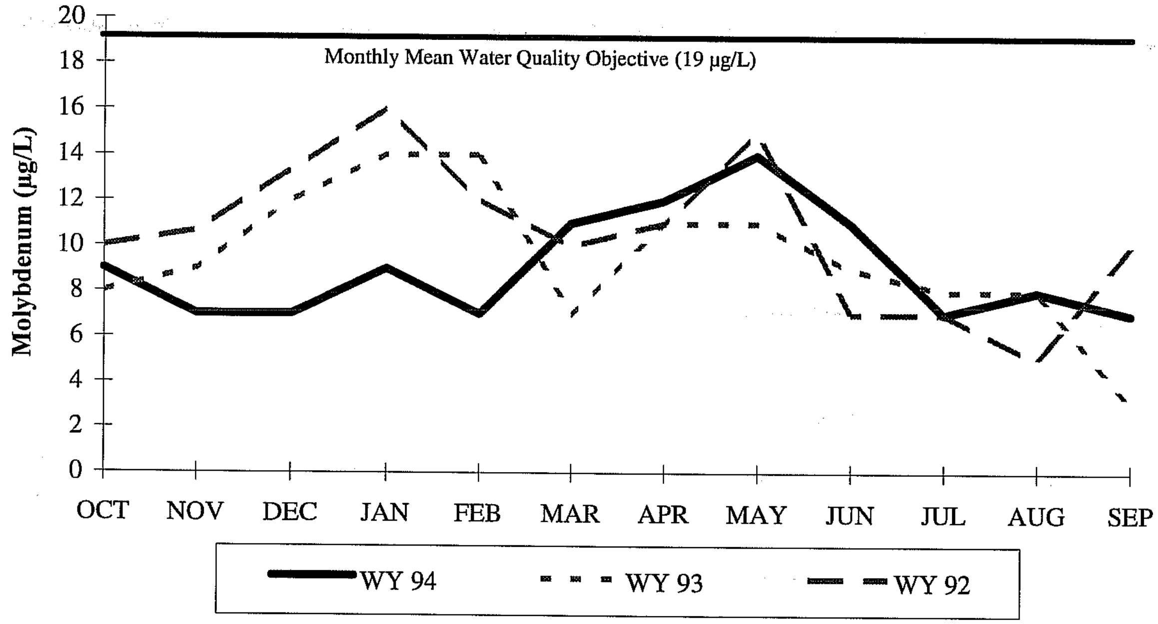


Figure 12
Monthly Mean Molybdenum Concentration in Salt Slough at Lander Avenue



Slough, the molybdenum objective was met throughout the entire WY. A concentration distribution pattern for molybdenum as a function of time was not apparent in either Mud Slough (north) or Salt Slough. The maximum molybdenum objective of 59 μg/L was met for all measurements in both sloughs.

The San Luis Spillway Ditch and the CCID Main Canal were monitored weekly during the wetland flooding period in October and monthly thereafter. The selenium water quality objective of 2.0 μg/L for waterfowl habitat supply water was met during October for both water bodies and for the San Luis Spillway Ditch year-round (Appendix B). The objective was, however, exceeded several times in the CCID Main Canal, with a maximum value of 3.8 μg/L. It is not known if the water supplies in the CCID Main Canal were used for wetland irrigation during periods in which the objective was exceeded. Water in the CCID Main Canal where it is measured at Russell Road, originates from the Delta-Mendota Canal. Selenium concentrations have been noted to exceed the waterfowl habitat supply objective (2 μg/L) in the Delta-Mendota Canal (Chilcott et al., 1995).

On 22 December 1992, the US Environmental Protection Agency (USEPA) promulgated the National Toxics Rule according to §303(c)(2)(B), of the Federal Clean Water Act. This promulgation included a more stringent selenium water quality criteria of 5 μg/L as a four-day average and a maximum criteria of 20 μg/L for Mud Slough (north) and Salt Slough. Frequency of data collection, in this monitoring program, does not allow for the calculation of four-day average concentrations. However, comparisons can be made with the monthly mean concentration. Based on this process, the criteria (5 μg/L) was met for Mud Slough (north) for the entire WY 94, but exceeded in Salt Slough for the entire WY except for October, the month when drainage water is not discharged because of wetland flood up. Additionally, the maximum criteria (20 μg/L) was exceeded in 53% of the measurements collected on Salt Slough.

In summary, selenium, boron, and salt loads remained elevated in WY 94, reversing the trend to lower loads realized during the extended drought of the late 1980s and early 1990s. The increased loads in WY 94 may be attributable to greater water use, particular for pre-plant irrigation. The increased loads coupled with more efficient water distribution and irrigation management has resulted in less available dilution flows and correspondingly increasing concentrations of the constituents of concern. Because the sloughs are effluent dominated, the only factor determining whether selenium water quality objectives are met in the particular slough is whether subsurface drainage water is being discharged to the slough. Boron in Mud Slough (north) presents a unique problem as objectives are not met whether subsurface drainage water is being discharged to the slough or not. For Salt Slough, however, meeting the objective for boron requires that subsurface drainage water not be discharged into the slough. Molybdenum is similar to boron in that the objective is exceeded in Mud Slough (north) regardless of whether subsurface drainage water is being discharge or not.

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APPENDIX A

Mineral and Trace Element Water Quality Data for Inflow Monitoring Stations
Listed in Order by Map Index Number

Main (Firebaugh) Drain at Russell Avenue (MER556)

Location: Latitude 36° 55' 27" Longitude 120° 39' 11". In SW 1/4, SW 1/4. SW 1/4, Sec. 34, T.11S., R. 12E. E side of Russell Avenue., 2.7 mi. S of South Dos Palos

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	Mo µg/L	Cr µg/L	Cu µg/L	Ni µg/L	Pb µg/L	Zn µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/1/93	911	71	7.1	2400	17							2.83			
10/8/93	850	66	7.8	2270	15							3.09			
10/15/93	640	64	7.2	5220	160							6.49			
10/21/93	1405	68	8.2	4940	53							7.84			
10/28/93	955	60	7.8	4030	43	52	9	6	46	<5	10	6.42	331	1320	927
11/5/93	700	54	6.6	3150	39							4.78			
11/12/93	822	56	7.9	2890	28							4.02			
11/22/93	935	52	7.8	3020	38							3.74			
11/28/93	950	53	7.8	3490	49	30	14	5	10	<5	15	4.48	278	1110	739
12/3/93	800	46	7.6	3950	45							5.29			
12/10/93	1005	56	7.8	2900	30							3.82			
12/17/93	846		7.8	3080	22							4.57			
12/28/93	955	44	8.0	5950	67	106	10	5	67	<5		9.64	669	2680	1370
1/7/94	857	40	8.2	4020	60							6.72			
1/14/94	927	46	7.7	3930	82							3.80			
1/21/94	909	49	8.1	4180	93							4.97			
1/28/94	1008	50	7.9	3700	69	19	25	30	37	<5	29	3.85	472	1120	822
2/3/94	1500	49	8.1	3510	68							3.69			
2/11/94	1020	49	8.0	4090	89							4.51			
2/17/94	1207	53	8.0	4530	114							4.84			
2/25/94	935	52	8.1	4910	107	21	34	22	69	<5	49	5.48	517	1640	1048
3/4/94	906	59	8.1	4880	118							5.72			
3/9/94	953	62	8.4	4990	119							6.16			
3/16/94	840	61	7.9	5010	126							6.10			
3/23/94	806	52	8.0	4600	87							5.40			
4/1/94	815	60	8.3	3850	83	29	27	24	13	<5	29	4.11	448	1230	884
4/6/94	854		8.0	5080	111							5.91			
4/15/94	820	62	8.8	4120	91							5.17			
4/21/94	945	62	7.8	3270	76							3.90			
4/27/94	930	59	8.2	3850	81	28	23	11	20	<5	22	4.69	461	1240	893
5/4/94	915	64	7.8	5910	136							7.00			
5/10/94	1225	74	8.2	4100	87							5.09			
5/16/94	935	63	8.0	5030	129							7.26			
5/25/94	1007	68	8.0	5220	106	32	22	13	16	<5	22	5.74	524	1380	983
6/1/94	850	70	7.6	3340	68							4.06			
6/8/94	715	62	8.0	3870	59							4.92			
6/15/94	855	63	7.7	2730	38							3.81			
6/21/94	900	68	8.2	3240	55							3.76			
6/29/94	905	74	7.8	2690	36		87	3.5	69	12		3.70	282	815	666
7/6/94	940	70	8.1	3300	63							3.00			
7/13/94	845	76	8.0	3450	66							4.50			
7/21/94	1035	74	8.0	2770	42							3.20			
7/27/94	1005	77	8.1	3250	46	19	29	20	28	5	43	4.40	290	1100	670
8/3/94	855	72	8.1	3200	46							4.00			
8/10/94	945	72	6.6	3140	57							4.00			
8/16/94	848	74	7.8	2550	34							3.20			
8/24/94	910	70	7.0	2470	33							3.00			
8/31/94	1105	74	7.8		98	29						6.90			1200
9/7/94	900	68	8.1	3550	45							3.60			
9/14/94	910	69	8.1	2890	47							3.50			
9/22/94	925	70	7.7	2670	26							3.40			
9/29/94	905	67	7.77	2840	29	18						3.20			540
	Count	50	52	51	52	11	10	10	10	10	8	52	10	10	12
	Min	40	6.6	2270	15	18	9	3.5	10	<5	10	2.83	278	815	540
	Max	77	8.8	5950	160	106	87	30	69	12	49	9.64	669	2680	1370
	Mean	62	7.9	3765	68	35	28	14	38	3	27	4.76	427	1364	895
	Geo Mean	61	7.9	3654	59	30	23	11	30	2	24	4.57	410	1298	867
	Median	63	8.0	3550	61	29	24	12	33	<5	26	4.49	455	1235	889

Panoche Drain at O'Banion Gauge Station (MER 501)

Location: Latitude 36° 55' 14" Longitude 120° 41' 43". In SW 1/4, SW 1/4, SW 1/4, Sec. 32. T. 11S R. T. 12E
Located 0.5 mi. S of CCID Main Canal, 1.9 mi. W of Russell Road., 5.5 mi. SW of Dos Palos 3.4 SW of South Dos Palos

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	Mo µg/L	Cr µg/L	Cu µg/L	Ni µg/L	Pb µg/L	Zn µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/1/93	933	70	7.0	4920	26							9.31			
10/8/93	909	66	7.7	5430	29							10.00			
10/15/93	705	64	7.7	5570	25							9.75			
10/21/93	1430	69	8.0	5030	68			4				9.20			
10/28/93	1020	60	7.8	4580	55		17	4	38	<5	7	7.71	626	1220	1130
11/5/93	715	54	7.0	4760	72							7.70			
11/12/93	839	54	7.6	3670	67							5.53			
11/22/93	950	55	7.6	4010	74							6.32			
11/28/93	1010	57	7.8	3780	66	8	24	4	<5	<5	7	6.55	450	947	929
12/3/93	810	49	7.6	3180	43							5.10			
12/10/93	1015	56	7.8	4500	88							7.13			
12/17/93	909		7.6	4290	73							6.77			
1/7/94	915	48	8.1	4750	91							7.46			
1/14/94	943	49	7.9	4840	100							7.26			
1/21/94	928	53	7.9	4600	73							6.97			
1/28/94	1015														
2/3/94	1445	56	8.3	4540	86							6.64			
2/11/94	1034	51	8.0	4170	66							6.07			
2/17/94	N/A														
2/25/94	955	55	7.9	4570	67	7	28	8	37	<5	17	8.19	607	1250	1187
3/4/94	920	57	7.8	5460	94							8.10			
3/9/94	1009	60	7.9	5190	50							8.44			
3/16/94	850	59	7.6	5090	86							9.41			
3/23/94	823	53	8.0	5180	113							9.12			
4/1/94	840	57	7.9	4840	115	12	44	12	6	<5	8	8.14	670	1410	1117
4/6/94	910		7.8	4970	101							8.70			
4/15/94	840	63	7.9	4710	87							7.90			
4/21/94	1000	62	7.8	5030	99							8.31			
4/27/94	945	60	8.0	4840	99	10	38	5	11	<5	7	9.21	655	1390	1350
5/4/94	928	65	7.7	5190	102							9.20			
5/10/94	1244	74	7.9	5020	100							9.18			
5/16/94	945	59	7.9	4700	89							7.87			
5/25/94	1027	68	8.0	4710	77	10						7.22	664	1440	1240
6/1/94	910	68	7.9	4730	95							7.99			
6/8/94	725	62	7.8	4650	69							7.76			
6/15/94	920	62	7.6	4810	74							7.95			
6/21/94	915	66	7.9	4900	91							7.80			
6/29/94	930	72	7.7	4360	65	9	42	9	16	<5		7.52	621	1230	938
7/6/94	855	70	7.9	4240	78							7.90			
7/13/94	908	72	7.7	4890	102							9.00			
7/21/94	1047	72	8.0	4890	96							8.80			
7/27/94	1020	74	7.8	4950	96	8	73	25	36	8	64	7.70	560	1600	1100
8/3/94	920	68	7.8	5290	106							8.70			
8/10/94	1000	71	7.9	5300	120							9.00			
8/16/94	903	72	7.6	4770	90							8.60			
8/24/94	925	70	7.1	4540	88							7.80			
8/31/94	1050	74	7.7	5280	129	13						7.30			1100
9/7/94	920	69	8.1	4770	110							6.70			
9/14/94	925	68	8.0	5080	121							8.70			
9/22/94	940	71	7.6	5470	140							8.50			
9/29/94	920	68	7.7	5750	156	13						9.60			1200
	Count	47	49	49	49	9	7	8	7	7	6	49	8	8	10
	Min	48	7.0	3180	25	7	17	4	<5	<5	7	5.10	450	947	929
	Max	74	8.3	5750	156	13	73	25	38	8	64	10.00	670	1600	1350
	Mean	63	7.8	4792	86	10	38	9	21	2	18	8.00	607	1311	1129
	Geo Mean	62	7.8	4765	81	10	35	7	13	2	12	7.92	602	1297	1122
	Median	63	7.8	4840	88	10	38	7	16	<5	8	7.95	624	1320	1124

Agatha Canal at Mallard Road(MER506)

Location: Latitude: 36° 56' 12", Longitude 120° 42' 07" In NE1/4, NW1/4, SW1/4, Sec. 7 T.11S, R.11E
South of Santa Fe Grade at Brito, West of Mallard Road. 4.5 miles west of Dos Palos.

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	Mo µg/L	Cr µg/L	Cu µg/L	Ni µg/L	Pb µg/L	Zn µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/1/93	957	74	7.7	520	1.8			11				0.40			139
10/8/93	933	68	8.3	700	2.0			9				0.55			167
10/15/93	730	66	7.9	3850	21			5				6.21			902
10/21/93	1510	68	8.6	450	1.7			4				0.31			113
10/28/93	1100	61	7.8	3810	42	19	7	7	37	<5	7	7.61	458	1070	1080
11/5/93	745	57	7.6	610	2.4							0.37			
11/12/93	981	58	7.9	470	1.1							0.21			
11/22/93	1010	54	6.9	600	2.2							0.29			
11/28/93	1035	54	8.2	560	1.5	1	4	4	5	<5	5	0.28	80.8	67.1	107
12/3/93	835	51	8.1	530	1.3							0.25			
12/10/93	1045	55	7.9	3560	52							5.27			
12/17/93	950		7.9	780	2.5							0.51			
12/28/93	1045	46	8.1	630	1.7	2						0.44	74.2	77.3	134
1/7/94	949	51	8.3	4730	100							9.42			
1/14/94	1223	51	8.0	4290	75							6.87			
1/21/94	954	52	8.1	3580	58							5.58			
1/28/94	1040	50	7.8	3950	66	10						5.28	514	1110	931
2/3/94	1512	51	8.3	4150	71							5.46			
2/11/94	1002	49	7.6	2240	2.0							3.71			
2/17/94	1220	52	8.2	1010	5.5							0.99			
2/25/94	1100	56	7.9	1110	3.7	4						1.37	138		
3/4/94	946	58	8.3	2150	3.2							3.49			
3/9/94	1030	59	8.2	3190	4.3							9.12			
3/16/94	910	61	7.8	1110								1.32			
3/23/94	847	48	8.0	3010	3.6							6.16			
4/1/94	930	58	8.1	3860	6.1	16						8.34	533	1064	808
4/6/94	940		7.7	4250	4.6							8.66			
4/15/94	905	63	8.1	4120	4.5							7.03			
4/21/94	1040	69	8.1	3470	16							6.04			
4/27/94	1010	61	8.7	4620	65	15						8.06	646	1460	1050
5/4/94	1000	69	8.0	5100	97							7.54			
5/10/94	1305	76	8.3	750	2.4							0.51			
5/16/94	1010	65	8.3	980	2.0							0.73			
5/25/94	1104	72	8.1	4100	68	15						6.08	600	1340	1010
6/1/94	940	71	8.0	3900	65							6.23			
6/8/94	835	64	8.0	4290	55							7.20			
6/15/94	945	66	7.8	4040	40							6.87			
6/21/94	936	69	8.2	1730	5.4							2.45			
6/29/94	1000	76	7.8	3320	14	11						5.85	478	911	756
7/6/94	920	70	8.3	3630	20							7.50			
7/13/94	925	79	8.0	3560	5.8							8.20			
7/21/94	1115	75	8.0	4260	66							7.10			
7/27/94	1120	75	8.0	3830	52	12						6.20	400	1100	770
8/3/94	940	73	8.0	4120	59							6.60			
8/10/94	1030	74	7.3	3980	61							7.00			
8/16/94	926	76	7.9	4060	54							7.40			
8/24/94	945	74	7.4	3660	40							6.50			
8/31/94	1125	74	7.7	4400	71	14						6.10			980
9/7/94	944	70	8.3	4090	62							5.50			
9/14/94	950	73	8.5	660	1.6							0.30			
9/22/94	1005	73	8.3	660	1.6							0.30			
9/29/94	1010	70	8.4	4180	87	18						6.00			870
	Count	50	52	52	51	12	2	6	2	2	2	52	10	9	15
	Min	46	6.9	450	1	1	4	4	5	<5	5	0.21	74.2	67.1	107
	Max	79	8.7	5100	100	19	7	11	37	<5	7	9.42	646	1460	1080
	Mean	64	8.0	2793	30	11	6	7	21	<5	6	4.57	392	911	654
	Geo Mean	63	8.0	2142	12	9	5	6	14	<5	6	2.67	308	616	476
	Median	66	8.0	3570	14	13		6				5.93	468	1070	808

Hamburg Drain near Camp 13 Slough (MER504)

Location: Latitude: 36° 56' 20" Longitude 120° 45' 26". In SE 1/4, SE 1/4 SW 1/4, Sec 27. T.11S., R.11E
50ft. S of CCID main canal, 9.2 mi. S-SE of Los Banos, 6.7 mi. W-SW of South Dos Palos

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	Mo µg/L	Cr µg/L	Cu µg/L	Ni µg/L	Pb µg/L	Zn µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/1/93	841	71	6.5	5620	92							7.00			
10/8/93	825	63	7.8	4570	43							6.37			
10/15/93	605	66	8.0	4730	48							6.35			
10/21/93	1325	70	7.7	5000	82							5.69			
10/28/93	853	62	7.4	5230	39	9	9	1	44	<5		8.84	618	1550	1860
11/5/93	640	55	6.5	5270	49							7.86			
11/12/93	753	54	7.2	5450	77							7.24			
11/22/93	858	58	7.0	5780	68							8.99			
11/28/93	910	57	7.9	5080	80	6	26	6	6	<5	13	5.32	586	1440	1620
12/3/93	715	50	6.6	4980	78							5.84			
12/10/93	940	56	8.1	4200	42							5.63			
12/17/93	816	67	6.7	5090	79							5.58			
12/28/93	900	49	7.6	4820	93	4	32	9	53	<5		4.85	815	2230	1690
1/7/94	819	42	7.0	4030	42							4.63			
1/14/94	849	44	8.2	4160	47							4.97			
1/21/94	837	47	8.1	3940	40							4.34			
1/28/94	924	44	7.9	3550	30	7	5	6	33	5	4	3.95	419	1230	1334
2/3/94	1415	60	9.6	3480	28							3.61			
2/11/94	848	43	8.0	3620	31							3.56			
2/17/94	N/A														
2/25/94	900	55	7.7	5470	99	4	62	18	60	<5	47	5.63	714	1510	1700
3/4/94	840	58	7.2	6110	109							5.60			
3/9/94	928	61	7.9	5440	86							5.81			
3/16/94	810	59	7.1	5540	99							6.12			
3/23/94	738	54	8.0	5940	108							6.20			
4/1/94	745	56	7.8	5130	102	6	18	13	6	<5	7	5.58	769	1560	1579
4/6/94	819		7.8	5320	90							5.83			
4/15/94	800	61	8.0	5510	100							6.59			
4/21/94	910	61	7.9	5640	104							6.53			
4/27/94	845	57	8.0	5780	105	7	22	3	<5	<5	6	6.73	866	1740	1740
5/4/94	840	61	6.9	5770	106							5.88			
5/10/94	1159	72	7.8	5520	98							5.95			
5/16/94	910	60	6.7	5790	102							5.99			
5/25/94	918	63	8.3	6540	181	8	8	3	<5	<5	5	7.76	1050	2270	1750
6/1/94	820	69	6.6	7100	201							7.93			
6/8/94	655	61	7.3	5920	99							7.20			
6/15/94	830	60	7.2	5890	106							6.57			
6/21/94	835	62	8.1	5720	124							5.37			
6/29/94	840	68	7.7	5770	123	8	2	8	<5	<5	4	5.85	865	1890	1941
7/6/94	810	72	7.8	5540	123							6.30			
7/13/94	825	68	8.0	5010	88							6.10			
7/21/94	945	73	8.0	5610	102							6.70			
7/27/94	940	70	7.8	5660	104	6	25	15	23	4	<10	6.80	710	1800	1500
8/3/94	840	66	7.1	5820	107							6.80			
8/10/94	900	69	5.6	4350	64							5.50			
8/16/94	815	67	7.3	4980	87							5.30			
8/24/94	850	68	5.9	5430	93							7.30			
8/31/94	1015	71	8.4	3470	39	8						3.70			1100
9/7/94	835	61	8.5	2960	17							3.10			
9/14/94	845	66	7.9	5150	88							6.40			
9/22/94	900	65	7.0	5080	69							5.70			
9/29/94	835	62	7.6	3400	28	7						4.30			1200
	Count	50	51	51	51	12	10	10	10	10	8	51	10	10	12
	Min	42	5.6	2960	17	4	2	1	6	<5	4	3.10	419	1230	1100
	Max	73	9.6	7100	201	9	62	18	60	5	47	8.99	1050	2270	1941
	Mean	61	7.5	5117	83	7	21	8	23	2	11	5.96	741	1722	1585
	Geo Mean	60	7.5	5037	74	6	14	6	10	2	7	5.82	721	1693	1564
	Median	61	7.8	5320	88	7	20	7	15	<5	6	5.88	742	1650	1655

Camp 13 Slough at Gauge Station (MER505)

Location: Latitude 36° 56' 21" Longitude 120° 45' 22". In SE 1/4, SE 1/4, SW 1/4, Sec. 27 T.11S., R.11E. 150 Ft. N of CCID Main Canal, 6.4 mi. W of Russell Avenue., 9.2 mi SE of Los Banos, 6.7 mi SW of South Dos Palos

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	Mo µg/L	Cr µg/L	Cu µg/L	Ni ug/L	Pb ug/L	Zn ug/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/1/93	850	73	7.4	390	1.2			23				0.29			156
10/8/93	834	68	8.5	650	1.8			8				0.38			163
10/15/93	615	68	8.3	550	1.9			7				0.33			137
10/21/93	1315	68	7.5	5040	68			5				8.98			1400
10/28/93	905	64	8.4	520	1.1	1	5	4	8	<5	6	0.31	58.1	72.8	112
11/5/93	645	54	6.5	4580	60							7.43			
11/12/93	806	54	7.6	3860	51							5.89			
11/22/93	905	55	7.5	3930	63							5.72			
11/28/93	920	54	7.9	3580	54			9	17			5.40	390	886	861
12/3/93	740	47	7.1	3220	37							4.73			
12/10/93	945	53	8.1	530	2.2							0.36			
12/17/93	824		7.2	4320	63							6.43			
12/28/93	915	49	7.9	4840	80	13						8.23	1290	2390	1260
1/7/94	829	44	8.0	700	2.3							0.46			
1/14/94	859	42	8.5	930	2.9							1.12			
1/21/94	846	47	8.4	1430	7.8							2.19			
1/28/94	932	47	7.8	3270	17	8						4.36	444	870	871
2/3/94	1420	50	8.5	3240	20							4.27			
2/11/94	859	50	8.4	610	3.1							0.35			
2/17/94	N/A														
2/25/94	905	54	7.9	4640	83	9						6.94	559	1300	7040
3/4/94	845	59	7.8	4870	94							9.14			
3/9/94	933	59	8.1	4710	95							10.3			
3/16/94	820	59	7.6	4920	91							7.25			
3/23/94	746	52	8.1	4930	96							7.26			
4/1/94	804	58	8.0	4310	83	14						6.34	586	1290	1053
4/6/94	828		7.8	4810	85							7.07			
4/15/94	805	62	8.0	4680	87							7.20			
4/21/94	920	63	8.2	3960	61							5.72			
4/27/94	855	59	8.3	4560	94	19						6.56	582	1380	1110
5/4/94	845	62	7.5	4730	84							5.81			
5/10/94	1225	75	8.1	4490	84							6.50			
5/16/94	915	60	7.5	4820	90							7.17			
5/25/94	930	62	8.4	2150	26	12						3.27	311	534	460
6/1/94	825	69	7.2	2590	51							2.44			
6/8/94	700	63	7.7	3980	48							5.78			
6/15/94	835	64	7.6	4040	58							5.67			
6/21/94	844	70	8.2	4200	64							5.96			
6/29/94	845	68	7.9	4150	74	20						6.05	525	1260	974
7/6/94	820	70	8.1	3870	64							5.90			
7/13/94	830	74	7.9	4140	66							6.90			
7/21/94	1003	74	8.0	3870	48							4.10			
7/27/94	945	76	8.3	4210	64	13						6.00	500	1400	950
8/3/94	850	70	7.9	4290	51							6.20			
8/10/94	910	70	6.4	3610	43							5.00			
8/16/94	828	72	7.9	3140	30							4.80			
8/24/94	900	71	6.3	3400	43							5.30			
8/31/94	1020	76	8.4	630	1.2	1						0.22			120
9/7/94	840	72	8.7	660	1.0							0.24			
9/14/94	850	69	8.1	4730	100							8.40			
9/22/94	905	69	7.5	4590	84							6.70			
9/29/94	845	71	8.6	760	1.0	1						0.26			140
	Count	49	51	51	51	11	1	6	2	1	1	51	10	10	16
	Min	42	6.3	390	1.0	1	5	4	8	<5	6	0.22	58.1	72.8	112
	Max	76	8.7	5040	100	20	5	23	17	<5	6	10.3	1290	2390	7040
	Mean	62	7.9	3326	51	10	5	9	13	<5	6	4.90	525	1138	1050
	Geo Mean	61	7.8	2654	27	6	5	8	12	<5	6	3.20	427	884	522
	Median	63	7.9	3960	58	12		8				5.78	512.5	1275	866

Charleston Drain at CCID Main Canal (MER502)

Location: Latitude 36° 56' 59" Longitude 121° 46' 48". In NE 1/4, SE 1/4, NE 1/4 Sec. 29, T.11S., R. 11E
N side of CCID Main Canal, 8.7 mi S-SE of Los Banos, 7.9 mi. W-SW of South Dos Palos

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	Mo µg/L	Cr µg/L	Cu µg/L	Ni µg/L	Pb µg/L	Zn µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/28/93	835		6.2	1550	14	3	11	5	22	<5	10	1.36	164	366	440
11/28/93	855	52	7.5	1620	14	4	8	4	<5	<5	7	1.47	183	367	483
1/28/94	912	50	7.4	4830	81	6	12	15	35	<5	13	5.96		1400	1493
2/25/94	842	54	7.3	5230	110	7	30	23	29	<5	17	4.20	737	1590	1510
4/1/94	730	58	7.7	3780	74	4	23	23	12	<5	36	3.28	560	1140	1138
4/27/94	830	58	8.2	5090	95	8	20	8	12	<5	19	4.63	698	1640	1520
5/25/94	900	62	7.6	5130	78	12	5	3	<5	<5	7	6.47	940	1540	1480
6/29/94	820	72	6.9	4540	87	9	12	5	7	<5	15	3.98	604	1520	1470
7/27/94	920	73	7.6	4720	97	7	18	15	19	4	48	4.40	550	1400	1200
8/31/94	1005	71	7.5	3370	51	4						2.80			900
9/29/94	820	78	7.2	2600	32	4						2.60			680
	Count	10	11	11	11	11	9	9	9	9	9	11	8	9	11
	Min	50	6.2	1550	14	3	5	3	<5	<5	<5	1.36	164	366	440
	Max	78	8.2	5230	110	12	30	23	35	4	48	6.47	940	1640	1520
	Mean	63	7.4	3860	67	6	15	11	15	2	19	3.74	555	1218	1119
	Geo Mean	62	7.4	3563	55	6	14	9	10	1	16	3.37	477	1070	1026
	Median	60	7.5	4540	78	6	12	8	12	<5	15	3.98	582	1400	1200

Almond Drive Drain (MER555)

Location: Latitude 36° 59' 55" Longitude 120° 49' 00". In SW 1/4, SW 1/4, SW 1/4, Sec. 6. T.11S., R.11E. N side of Almond Dr., 1.1 mi E of Mercy Springs Drain, 100ft. E of CCID Main Canal, 4.7 mi. S. of Los Banos

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	Mo µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/28/93	815	60	5.8	450	0.4		0.22	49.3	50.4	112
11/28/93	835	54	7.6	570	1.4	3	0.24	76.1	54.7	106
12/28/93	830	44	6.3	540	0.9		0.27	68.2	65.5	108
1/28/94	741	51	6.7	1890	4.6		1.98	225	381	432
2/25/94	825	52	7.1	720	2.0		0.48	94.6	105	161
4/1/94	700	58	7.8	2620	4.7		3.09	326	666	620
4/27/94	810	59	8.5	800	1.4		0.51	103	129	170
5/25/94	749	61	7.8	2120	4.6		2.13	273	450	481
6/29/94	805	70	6.2	860	1.8		0.86	119	123	293
7/27/94	900	72	8.4	930	2.2		0.65	110	110	190
8/31/94	945	72	7.9	1370	2.1		1.30			300
9/29/94	800	70	7.2	820	2.3		0.31			170
	Count	12	12	12	12	1	12	10	10	12
	Min	44	5.8	450	0.4	3	0.22	49.3	50.4	106
	Max	72	8.5	2620	4.7	3	3.09	326	666	620
	Mean	60	7.3	1141	2.4	3	1.00	144	213	262
	Geo Mean	60	7.2	977	1.9	3	0.68	121	144	220
	Median	60	7.4	840	2.1		0.58	107	117	180

Rice Drain at Mallard Road (MER509)

Location: Latitude 36° 59' 22" Longitude 120° 14' 42". In NE 1/4, NW 1/4, SW 1/4, Sec. 7, T.11S., R11E
South of Santa Fe Grade at Brito, 50 ft. West of Mallard Road, 4.5 mi. West of Dos Palos

Date	Time	Temp F	pH	EC uhmos/cm	Se ug/L	Mo ug/L	Cu ug/L	Ni ug/L	Pb ug/L	Zn ug/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/28/93	1135	63	7.8	2210	4.0	12	11	38	<5	29	4.31	222	564	476
11/28/93	1100	56	8.0	2540	3.0	11					4.91	262	596	558
12/28/93	1030	46	7.8	2740	1.3	15					4.85	400	672	641
1/28/94	1033	48	7.5	3210	1.3	28					5.35	352	975	843
2/25/94	1110	43	7.6	3930	3.0	15					8.99	521	1060	874
4/1/94	915	58	8.3	7700	5.8	57								
4/27/94	1020	60	8.3	3720	3.4	17					8.70	511	1110	808
5/25/94	1054	70	8.1	2910	4.6	23					5.74	322	923	802
6/29/94	1005	74	7.8	3030	2.6	20					5.74	366	866	674
7/27/94	1050	76	8.1	2520	3.6	15					4.8	270	670	500
8/31/94	1120	74	7.8	2190	2.3						4.0			510
9/29/94	1000	68	8.3	4740	5.4	29					11.0			880
	Count	12	12	12	12	11	1	1	1	1	11	9	9	11
	Min	43	7.5	2190	1.3	11	11	38	<5	29	4.0	222	564	476
	Max	76	8.3	7700	5.8	57	11	38	<5	29	11.0	521	1110	880
	Mean	61.3	8.0	3453	3.3	22	11	38	<5	29	6.22	358	826	688
	Geo Mean	60.3	7.9	3228	3.0	20	11	38	<5	29	5.9	345	803	670
	Median	61.5	7.9	2970	3.2	17					5.35	352	866	674

Boundry Drain at Department of Fish and Game Pump (MER521)

Location: Latitude 37° 06' 32" Longitude 120° 46' 44" In NE 1/4, SE 1/4, NE 1/4. Sec. 32., T.9S., R11E. North of Henry Miller Road. 4.6 mi. NE of Los Banos

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/29/93	940	61	7.7	1090	0.6	0.46	152	130	223
11/30/93	920	54	7.5	1690	0.8	0.65	299	226	315
12/28/93	1200	52	7.7	2170	0.5	0.77	374	286	460
1/28/94	1158	50	7.5	1640	0.6	0.79	302	235	373
2/25/94	1230	55	7.5	2000	1.6	0.74	375	276	389
4/1/94	1130	64	7.1	1900	1.8	0.76	288	278	396
4/27/94	1158	59	8.1	1510	0.8	0.56	266	188	302
5/25/94	1105	74	7.5	1810	1.1	0.73	341	219	374
6/29/94	1120	77	7.7	1840	1.4	0.64	310	203	338
7/27/94	1230	79	8.2	1190	1.9	0.49	170	140	230
8/31/94	850	72	7.3	1120	1.2	0.43			230
9/29/94	1135	73	8.3	1180	1.4	0.37			220
	Count	12	12	12	12	12	10	10	12
	Min	50	7.1	1090	0.5	0.37	152	130	220
	Max	79	8.3	2170	1.9	0.79	375	286	460
	Mean	64	7.7	1595	1.1	0.62	288	218	321
	Geo Mean	63	7.7	1553	1.0	0.60	277	211	311
	Median	63	7.6	1665	1.1	0.65	301	223	327

Salt Slough Ditch at Hereford Road (MER528)

Location: Latitude 37° 08' 30" Longitude 120° 45' 17" In NW 1/4, NE 1/4, NW 1/4, Sec. 22 T.9S., R11E. 3.0 mi. N on Hereford Road from Henry Miller Road

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	Cu µg/L	Ni µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/1/93	1125	75	7.5	730	0.9	6		0.27			179
10/8/93	1054	67	8.0	720	0.9	10		0.29			121
10/15/93	845	66	7.9	780	0.5	7		0.26			199
10/21/93	1615	69	7.8	780	0.3	7		0.24			194
11/30/93	900	54	7.8	930	0.6	6	7	0.28	139	91.1	202
12/28/93	1220	49	7.7	1150	0.7			0.34	155	125	269
1/28/94	1213	49	7.5	1040	0.8			0.32	168		248
2/25/94	1247	56	7.4	1370	1.0			0.34	219	172	338
4/1/94	1100	64	7.5	1140	1.4			0.51	218	172	313
4/27/94	1215	60	7.7	1300	0.7			0.41	202	166	308
5/25/94	1120	74	7.9	1140	0.9			0.43	178	150	265
6/29/94	1130	79	7.7	810	0.8			0.46	119	112	182
7/27/94	1253	82	7.7	1020	0.7			0.39	140	120	230
8/31/94	830	70	7.3	1050	0.9						
9/29/94	1150	74	7.9	840	0.7			0.24			160
	Count	15	15	15	15	5	1	14	9	8	14
	Min	49	7.3	720	0.3	6	7	0.24	119	91.1	121
	Max	82	8.0	1370	1.4	10	7	0.51	219	172	338
	Mean	66	7.7	990	0.8	7	7	0.34	171	139	229
	Geo Mean	65	7.7	970	0.7	7	7	0.33	167	135	221
	Median	67	7.7	1020	0.8	7	7	0.33	168	138	216

APPENDIX B

Mineral and Trace Element Water Quality Data for Internal Flow Monitoring Stations
Listed in Order by Map Index Number

CCID Main at Russell Avenue (MER510)

Location: Latitude 36° 55' 28" Longitude 120° 39' 11" In SE 1/4, SE 1/4, SE 1/4, Sec. 33 T.11S., R12E. 2.7 mi. south of Dos Palos

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	Mo µg/L	Cr µg/L	Cu µg/L	Ni µg/L	Pb µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/1/93	919	71	7.5	580	1.6			10			0.33			154
10/8/93	855	67	8.2	420	1.3			8			0.21			112
10/15/93	650	66	8.2	400	1.1			6			0.21			110
10/21/93	1405	69	7.8	390	1.4			4			0.20			96.8
10/28/93	945	64	7.7	440	0.4		4	5	8	<5	0.27	48.2	60.9	107
11/28/93	945	54	8.3	700	2.2			4	<5		0.39	88.7	77	144
12/28/93	950	46	8.3	600	1.9						0.42	78.6	77.4	136
1/28/94	1008	48	8.1	650	1.9	2					0.35	89.3	80.5	147
2/25/94	930	53	8.0	720	3.8						0.41	90.5	106	154
4/1/94	815	60	8.2	940	2.5						0.44	99.4	109	153
4/27/94	920	59	8.5	810	1.7						0.51	99.7	116	171
5/25/94	1000	65	8.3	920	1.9						0.55	121	175	192
6/29/94	905	72	8.1	690	2.5						0.39	93.1	110	149
7/27/94	1005	77	8.7	750	1.7						0.40	95	99	140
8/31/94	1035	77	8.2	630	0.9						0.22			120
9/29/94	900	70	8.2	720	0.8						0.20			130
	Count	16	16	16	16	1	1	6	2	1	16	10	10	16
	Min	46	7.5	390	0.4	2	4	4	<5	<5	0.20	48.2	60.9	96.8
	Max	77	8.7	940	3.8	2	4	10	8	<5	0.55	121	175	192
	Mean	64	8.1	648	1.7	2	4	6	5	<5	0.34	90	101	138
	Geo Mean	63	8.1	625	1.5	2	4	6	3	<5	0.32	88	97	136
	Median	66	8.2	670	1.7			6			0.37	91.8	102.5	142

Santa Fe Canal at Henry Miller Road (MER519)

Location: Latitude 37 05'59" Longitude 120 49'44" In NE 1/4, NE 1/4 Sec. 1 T.10S, R.10E 0.3 miles East of Lander Avenue. 3.0 miles North of Gustine

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/1/93	1053	73	8.0	450	1.4	0.29			
10/8/93	1024	68	8.6	500	1.6	0.33			
10/15/93	755	68	8.1	1560	0.8	0.32			
10/21/93	1545	70	8.4	410	0.7	0.22			
10/29/93	851	68	7.0	590	0.3	0.30	59.7	62.8	118
11/5/93	800	58	7.8	500	0.7	0.28			
11/12/93	937	58	8.0	600	0.9	0.31			
11/22/93	1030	54	8.0	530	0.9	0.25			
11/30/93	820	53	8.0	650	1.0	0.38	89.4	81.1	142
12/3/93	920	49	8.1	690	1.0	0.45			
12/10/93	1115	54	8.1	600	1.3	0.38			
12/17/93	1034		7.8	770	1.5	0.49			
12/28/93	1140	48	8.1	720	1.5	0.46	86.8	102	158
1/7/94	1032	44	8.5	790	1.9	0.53			
1/14/94	1305	48	8.4	840	1.9	0.91			
1/21/94	1020	48	8.4	710	1.3	0.38			
1/28/94	1131	51	6.6	2440	23	3.19	311	581	564
2/3/94	1535	50	8.1	3380	35	4.91			
2/11/94	1127	51	8.1	1010	3.0	1.10			
2/17/94	DRY								
2/25/94	1155	56	8.3	1460	2.1	1.72	160	278	298
3/4/94	1012	61	7.9	4090	59	5.08			
3/9/94	849	60	8.1	4000	60	5.28			
3/16/94	DRY								
3/23/94	915	51	8.7	1290	3.8	1.07			
4/1/94	1020	63	8.7	1300	3.3	1.31	177	262	275
4/6/94	1012		8.1	1230	3.4	1.11			
4/15/94	940	64	8.1	1370	2.6	1.26			
4/21/94	1110	70	8.4	1270	2.9	1.32			
4/27/94	1120	60	8.5	1160	2.5	1.10	147	208	279
5/4/94	1035	68	7.9	1330	2.3	1.13			
5/10/94	DRY								
5/16/94	DRY								
5/25/94	DRY								
6/1/94	1015	70	8.2	1370	3.4	1.24			
6/8/94	915	64	8.0	920	2.8	0.74			
6/15/94	1015	62	8.2	1130	3.0	0.80			
6/21/94	100	71	8.4	880	3.2	0.53			
6/29/94	1050	78	8.0	920	2.2	0.70	123	140	221
7/6/94	950	69	8.6	1060	3.2	0.76			
7/13/94	1000	74	8.3	1350	3.0	1.20			
7/27/94	DRY				0.2				
8/3/94	DRY				0.1				
8/10/94	DRY				0.7				
8/24/94	1010	74	7.7	840	1.8	0.55			
8/31/94	DRY				0.9				
9/14/94	1010	74	8.2	720	1.6	0.30			
9/22/94	1050	75	8.0	670	1.1	0.30			
9/29/94	1100	74	8.2	800	1.6	0.33			160
	Count	38	40	40	44	40	8	8	9
	Min	44	6.6	410	0.1	0.22	59.7	62.8	118
	Max	78	8.7	4090	59.8	5.28	311	581	564
	Mean	62	8.1	1173	5.7	1.08	144	214	246
	Geo Mean	61	8.1	986	2.0	0.71	128	168	220
	Median	63	8.1	900	1.8	0.63	135	174	221

San Luis Canal at Henry Miller Road (MER532)
Location:

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/1/93	1100	75	8.0	550	2.6	0.35			
10/8/93	1030	68	8.2	630	1.7	0.51			
10/15/93	805	66	8.3	490	4.0	2.05			
10/21/93	1635	69	8.2	480	1.3	0.34			
10/29/93	859	62	7.6	550	0.7	0.36	67.3	78.7	131
11/5/93	805	59	7.9	500	1.2	0.35			
11/12/93	913	58	8.1	680	1.7	0.41			
11/22/93	1048	52	8.0	620	1.7	0.40			
11/30/93	930	55	8.0	760	1.8	0.49	104	99.5	169
12/3/93	910	51	8.0	800	1.8	0.59			
12/17/93	1038		7.8	2080	15	2.69			
12/28/93	1145	47	8.1	740	2.0	0.52	88.4	108	170
1/7/94	1035	46	8.3	820	2.5	0.58			
1/14/94	1311	49	8.4	790	1.2	0.77			
1/21/94	1027	50	8.6	1180	8.2	1.10			
1/28/94	1137	50	7.2	2610	24.2	3.37	324	619	593
2/3/94	1540	55	8.5	1930	11.6	2.31			
2/11/94	1132	52	8.0	3040	34.2	4.40			
2/17/94	745	52	8.0	2700	24.9	3.46			
2/25/94	1200	57	7.9	3560	44.9	4.75	447	998	849
3/4/94	1017	62	7.9	4010	56.6	4.93			
3/9/94	844	58	8.2	2810	33.6	3.29			
3/16/94	950	62	7.8	1220	3.9	0.85			
3/23/94	923	55	7.9	1380	5.5	1.08			
4/1/94	1030	63	7.8	1110	3.1	1.03	139	208	244
4/6/94	1021		7.9	1100	3.1	0.84			
4/15/94	950	67	8.1	1130	3.2	1.02			
4/21/94	1115	69	7.9	1220	2.8	1.09			
4/27/94	1130	60	8.3	1160	2.5	0.96	141	210	257
5/4/94	1040	69	7.9	1170	2.6	0.88			
5/10/94	1402	77	7.8	1060	2.3	0.91			
5/16/94	1050	63	8.0	830	2.2	0.58			
5/25/94	1215	72	7.6	1150	3.1	0.94	160	211	287
6/1/94	1025	71	8.1	940	2.9	0.70			
6/8/94	910	64	8.4	910	1.7	0.67			
6/15/94	1020	65	8.0	1010	1.7	0.93			
6/21/94	1005	70	8.2	890	3.1	0.55			
6/29/94	1055	78	7.9	940	2.1	0.78	121	150	261
7/6/94	1000	71	8.1	950	2.2	0.73			
7/13/94	1005	78	8.2	1010	2.5	0.82			
7/21/94	858	73	8.3	950	3.0	0.67			
7/27/94	1205	78	8.1	1030	3.0	0.77	120	160	200
8/3/94	1010	72	8.0	1320	3.0	1.20			
8/10/94	1100	73	7.8	1030	1.7	0.86			
8/16/94	953	76	8.0	1020	2.0	0.81			
8/31/94	810	73	7.5	790	1.6	0.42			160
9/7/94	1020	72	8.6	900	1.6	0.48			
9/14/94	1015	73	8.1	720	1.8	0.30			
9/22/94	1045	73	8.1	800	3.6	0.40			
9/29/94	1105	74	8.1	870	2.3	0.42			170
	Count	48	50	50	50	50	10	10	12
	Min	46	7.2	480	0.7	0.30	67.3	78.7	131
	Max	78	8.6	4010	57	4.93	447	998	849
	Mean	64	8.0	1219	7.0	1.19	171	284	291
	Geo Mean	64	8.0	1055	3.4	0.87	145	202	246
	Median	66	8.0	980	2.5	0.80	130	184	222

San Luis Canal at Highway 152 (MER527)

Latitude 37° 03' 27" Longitude 120° 48' 11". In SE 1/4, SW 1/4, SE 14
Sec. 18, T.10S R.11E. North side of highway 152, 2.5 mi. east of Los Banos

Date	Time	Temp F	pH	EC uhmos/cm	Se ug/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/28/93	1215	63	8.4	530	0.6	0.34	60.2	69	129
11/28/93	1130	55	8.9	770	1.6	0.46	100	100	160
12/28/93	1120	48	7.7	690	1.5	0.45	88.5	95.2	146
1/28/94	1109	48	8.2	1910	3.3	2.18	245	349	391
2/25/94	1140	58	8.0	1960	5.5	2.17	219		
4/1/94	1000	62	7.9	990	2.7	0.77	117	180	210
4/27/94	1100	63	8.5	1080	1.7	0.85	134	203	221
5/25/94	1141	72	8.3	1020	1.7	0.65	123	196	212
6/29/94	1040	78	8.2	850	2.2	0.60	110	131	191
7/27/94	1130	79	8.6	880	1.4	0.58	120	120	150
8/31/94	930	73	7.9	3550	51	5.00			780
9/29/94	1045	74	8.5	790	1.4	0.34			150
	Count	12	12	12	12	12	10	9	11
	Min	48	7.7	530	0.6	0.34	60.2	69	129
	Max	79	8.9	3550	51	5.00	245	349	780
	Mean	64	8.2	1252	6.2	1.20	132	160	249
	Geo Mean	64	8.2	1076	2.4	0.81	122	144	212
	Median	63	8.2	935	1.7	0.62	119	131	191

Porter-Blake Bypass (MER 548)

Location: Latitude 37° 05' 58.5" Longitude 120° 49' 14.5" In NW 1/4, Sec. 1, R.10E, T.10S
7.5 miles east of intersection of Henry Miller Road and Mercy Springs Road.
2 miles north of Los Banos.

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/1/93	1107	74	7.8	550	2.9	0.40			
10/8/93	1034	68	8.1	540	2.0	0.56			
10/15/93	815	66	8.2	440	0.7	0.24			
10/21/93	1600	71	7.8	3140	26	5.26			
10/29/93	911	63	7.6	1680	10	2.39	185	363	393
11/5/93	810	60	7.6	2620	21	4.03			
11/12/93	948	58	7.8	1930	12	2.62			
11/22/93	1040	52	7.8	2200	19	3.03			
11/30/93	835	54	7.9	1960	16	2.50	225	463	435
12/3/93	900	51	7.8	2280	18	3.06			
12/10/93	1105	56	7.9	2390	20	3.30			
12/17/93	1043		7.9	2140	15	3.28			
12/28/93	1150	48	7.9	2530	26	3.29	279	581	581
1/7/94	1039	44	8.1	2460	23	3.59			
1/14/94	1321	50	8.0	3160	33	4.80			
1/21/94	1038	52	8.1	3120	35	4.12			
1/28/94	1146	50	7.4	2640	24	3.34	338	618	589
2/3/94	1530	50	8.2	350	36	5.00			
2/11/94	1140	52	8.0	3040	34	3.70			
2/17/94	738	52	7.7	2790	31	3.37			
2/25/94	1205	58	7.9	3620	47	4.87	464	1040	862
3/4/94	1028	62	7.8	4290	66	5.33			
3/9/94	900	61	8.2	4060	61	5.32			
3/16/94	945	62	7.8	4390	53	5.78			
3/23/94	933	56	7.9	1260	3.4	1.06			
4/1/94	1045	64	8.0	3910	57	5.76	526	1110	962
5/10/94	1350	77	8.0	4140	72	5.82			
5/16/94	1040	64	8.0	4630	78	7.13			
5/25/94	1220	74	8.3	2960	35	4.78	431	897	718
6/1/94	1045	74	8.1	3540	56	5.17			
6/8/94	925	65	8.0	4240	59	6.64			
6/15/94	1035	68	8.1	4150	50	6.53			
6/21/94	1017	72	8.0	3720	52	5.46			
6/29/94	1105	78	7.7	3620	52	5.40	462	1030	880
7/6/94	1005	71	8.1	3770	66	6.10			
7/13/94	1015	78	7.9	4090	72	6.00			
7/21/94	847	77	8.3	3960	58	6.60			
7/27/94	1215	70	8.1	3490	49	5.00	400	1000	700
8/3/94	1030	74	8.1	3730	53	5.70			
8/10/94	1110	75	7.8	3540	46	5.40			
8/16/94	1005	78	7.9	3390	40	5.40			
8/24/94	1030	74	7.6	3530	44	5.20			
8/31/94	905		7.7	3770	49	5.30			810
9/7/94	1030	72	8.3	3420	58	4.20			
9/14/94	1025	74	8.3	3030	46	3.60			
9/22/94	1030	74	7.9	3800	63	5.10			
9/29/94	1110	73	7.9	3060	53	4.20			620
	Count	45	47	47	47	47	9	9	11
	Min	44	7.4	350	0.7	0.24	185	363	393
	Max	78	8.3	4630	77.8	7.13	526	1110	962
	Mean	64	7.9	3001	39.2	4.36	368	789	686
	Geo Mean	64	7.9	2654	29.5	3.75	349	737	662
	Median	65	7.9	3160	43.6	4.87	400	897	700

San Luis Spillway Ditch @ Santa Fe Grade (MER537)

Location: Latitude 37° 08' 37.2" Longitude 120° 52' 22.9" In SE 1/4, SE 1/4, Sec. 16, R.10E, T.9S.
3.4 miles north west of the intersection of Mercy Springs Road and old Santa Fe Grade
5.5 miles north of Los Banos.

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	Cr µg/L	Cu µg/L	Ni µg/L	Pb µg/L	Zn µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/1/93	1142	74	7.6	420	0.8		7				0.21			113
10/8/93	1119	71	8.1	450	0.7		6				0.21			121
10/15/93	920	68	7.9	350	0.4		7				0.16			
10/21/93	1655	68	8.0	380	0.3		5				0.18			94.2
10/29/93	1021	63	8.0	510	0.4	20	7	15	<5	8	0.28	58.9	44.6	120
11/5/93	915	62	7.8	570	0.6						0.31			
11/30/93	940	55	7.9	880	0.5		6				0.59	126	85.1	170
12/28/93	1240	47	8.0	820	0.7						0.52	105	89.1	171
1/28/94	1232	52	7.8	1580	0.3						1.15	243	170	246
2/25/94	1300	56	8.1	1020	1.2						0.80	138	133	210
4/1/94	1130	69	8.1	1520	0.9						1.29	199	230	260
4/27/94	1250	60	8.7	1420	0.7						1.23	199	166	240
5/25/94	1239	74	8.8	1110	0.8						0.90	182	129	227
6/29/94	1140	84	8.3	810	0.7						0.57	118	92	183
7/27/94	1314	85	8.6	840	0.5						0.50	120	74	160
8/31/94	745	75	7.2	950	0.5						0.57			160
9/29/94	1220	74	7.8	760	0.6						0.30			150
	Count	17	17	17	17	1	6	1	1	1	17	10	10	15
	Min	47	7.2	350	0.3	20	5	15	<5	8	0.16	58.9	44.6	94.2
	Max	85	8.8	1580	1.2	20	7	15	<5	8	1.29	243	230	260
	Mean	67	8.0	846	0.6	20	6	15	<5	8	0.57	149	121	175
	Geo Mean	66	8.0	763	0.6	20	6	15	<5	8	0.46	139	110	168
	Median	68	8.0	820	0.6		7				0.52	132	111	170

APPENDIX C

Mineral and Trace Element Water Quality Data for Outflow Monitoring Stations
Listed in Order by Map Index Number

Mud Slough at Newman Gun Club (MER551)

Location: Latitude 37° 18' 33" Longitude 120° 57' 18" In NW 1/4, NW 1/4, SW 1/4, Sec. 23, T.7S., R.9E., 1.7 mi. NE of Santa Fe Grade, 1.2 mi. N of Hwy 140. 4.2 mi. NE of Gustine

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	Cr µg/L	Cu µg/L	Ni µg/L	Pb µg/L	Zn µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/1/93	1429	86	7.7	2920	1.3						2.05			
10/8/93	1414	75	8.4	1640	1.2						1.21			
10/15/93	1155	74	8.0	1130	1.1						1.09			
10/21/93	840		7.8	1010	0.8						0.70			
10/29/93	1406	69	7.7	900	0.6						0.63	104	100	199
11/5/93	1015	67	7.4	1200	0.6						0.82			
11/30/93	1245	56	7.9	1340	0.5		2				0.97	168	181	254
12/28/93	1030	45	7.6	1520	0.5	5	4	11	<5	<5	1.05	203	235	291
1/27/94	1230	54	8.0	1750	1.9		8				1.32	230	252	319
2/23/94	1250	56	8.2	4810	1.0		1				3.43	761	1060	834
4/27/94	1257	62	7.8	3330	1.6		6				2.60	469	650	655
5/25/94	925	72	6.7	3100	1.3	8	4	7	<5	7	2.37	511	679	547
6/29/94	1020	80	7.9	3160	1.4	6	7	7	<5	9	2.37	487	663	580
7/27/94	1045	79	8.0	1650	1.1						1.20	220	260	260
8/31/94	1350	88	8.5	1490	1.2						2.00			670
9/29/94	1110	75	7.6	1570	1.0						0.85			290
	Count	15	16	16	16	3	7	3	3	3	16	9	9	11
	Min	45	6.7	900	0.5	5	1	7	<5	<5	0.63	104	100	199
	Max	88	8.5	4810	1.9	8	8	11	<5	9	3.43	761	1060	834
	Mean	69	7.8	2030	1.1	6	5	8	<5	6	1.54	350	453	445
	Geo Mean	68	7.8	1800	1.0	6	4	8	<5	4	1.36	293	354	399
	Median	72	7.9	1600	1.1	6	4	7		7	1.21	230	260	319

Mud Slough at San Luis Drain (MER542)

Location: Latitude 37° 19' 50" Longitude 120° 57' 03". In NW 1/4, NE 1/4, NW 1/4, Sec. 14 T.7S., R.9
5.0 miles east of Gustine, 3.5 miles SE of Hwy 140. Located inside of Kesterson N.W.R.

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	Mo µg/L	Cr µg/L	Cu µg/L	Ni µg/L	Pb µg/L	Zn µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/1/93	1238	76	7.6	2130	1.6			5				1.44			450
10/8/93	1219	69	8.1	1510	1.5			6				1.03			294
10/15/93	1000	68	7.8	960	0.7			4				0.66			201
10/21/93	730		8.1	850	0.9			3				0.60			188
10/29/93	1202	67	7.1	870	1.8	5									
11/5/93	945	59	7.3	1050	0.4							0.75			
11/12/93	1022	58	7.8	1070	0.6							0.70			
11/22/93	1120	53	7.6	1130	0.7							0.85			
11/30/93	1020	53	7.8	1260	0.4	6		4				0.92	158	162	231
12/3/93	950	49	7.8	1310	0.7							1.11			
12/10/93	1230	56	8.0	1390	0.6							0.98			
12/17/93	1123		7.8	1300	0.7							0.06			
12/28/93	1305	46	7.8	1480	0.7	4	5	7	42	<5	<5	0.98	196	210	262
1/7/94	1130	49	8.0	1830	0.4							1.36			
1/14/94	1427	49	8.1	2010	0.3							1.58			
1/21/94	1112	52	8.1	1610	0.5							1.18			
1/28/94	1305	50	7.8	1800	2.8	7	11	7	15	<5	5	1.48	259	277	315
2/3/94	1410	50	7.2	2020	1.5							1.40			
2/11/94	1225	51	8.0	2010	1.2							1.48			
2/17/94	820	52	8.1	2030	0.8							1.55			
2/25/94	1420	59	8.0	1670	0.6							0.98	265	172	345
3/4/94	1100	62	7.7	2490	0.9							1.89			
3/9/94	808	60	8.0	2300	2.1							1.94			
3/16/94	1030	63	7.7	2780	1.0							2.12			
3/23/94	1014	58	8.0	2710	1.7							1.99			
4/1/94	1210	70	7.8	3860	1.0		1		7	<5	10	3.09	621	779	616
4/6/94	1029		8.1	3370	1.3							3.02			
4/15/94	1100	71	8.2	2910	1.4							2.28			
4/21/94	1218	71	7.7	4330	1.0							3.35			
4/27/94	1400	59	8.1	3860	1.2	18	5	3	8	<5	4	3.31	561	723	706
5/4/94	1135	71	7.7	5630	1.0							3.83			
5/10/94	1440	82	8.0	2960	1.0							2.07			
5/16/94	1125	65	8.0	4190	1.9							3.16			
5/25/94	1305	78	7.8	4960	0.9	27	10	4	8	<5	8	4.40	941	1390	883
6/1/94	1140	72	7.9	4870	0.7							3.91			
6/8/94	1035	64	7.9	4730	0.8							3.37			
6/15/94	1115	69	7.9	5650	0.8							4.15			
6/21/94	1055	64	8.1	5380	1.5							3.68			
6/29/94	1245	84	8.1	4730	1.5	20	7	3	6	<5	5	3.44	790	1190	857
7/6/94	1050	74	8.6	3130	1.7							2.40			
7/13/94	1045	78	8.1	4480	1.3							2.30			
7/21/94	1302	76	8.1	4630	1.3							3.30			
7/27/94	1411	82	8.5	3390	1.0	11	9	7	10	3	<10	2.20	490	740	560
8/3/94	1100	74	8.4	1960	3.2							1.50			
8/10/94	1200	72	7.9	3660	0.9							2.50			
8/16/94	1039	76	8.0	2840	1.1							2.00			
8/24/94	1100	72	7.6	2950	0.8							2.00			
8/31/94	1520	80	8.4	3480	0.9	12						2.20			610
9/7/94	1100	72	8.4	2560	1.4							1.50			
9/14/94	1105	71	8.2	2640	0.9							1.50			
9/22/94	1125	75	7.7	880	0.9							0.20			
9/29/94	1310	75	8.0	2400	0.9	6						1.40			390
	Count	49	52	52	52	10	7	11	7	7	7	51	9	9	15
	Min	46	7.1	850	0.3	4	1	3	6	<5	4	0.06	158	162	188
	Max	84	8.6	5650	3.2	27	11	7	42	3	10	4.40	941	1390	883
	Mean	65	7.9	2730	1.1	12	7	5	14	2	5	1.98	476	627	461
	Geo Mean	65	7.9	2380	1.0	10	6	5	11	1	4	1.62	401	470	408
	Median	68	8.0	2520	1.0	9	7	4	8	<5	<5	1.89	490	723	390

Revised: 2/3/95

Los Banos Creek at State Highway 140 (MER554)

Location: Latitude 37° 16' 35" Longitude 120° 57' 14". In NE 1/4, SW 1/4, SW 1/4, Sec. 35, T.7S., R.9E. South side of Highway 140, 2.9 mi. NE of Gustine

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/29/93	1325	69	7.9	670	0.6	0.37	72.8	60.6	155
11/30/93	1150	55	8.3	770	0.6	0.48	103	83.9	154
12/28/93	1110	59	7.8	1080	0.5	0.69	144	140	215
1/27/94	1300	54	8.0	1280	0.3	0.89	168	138	245
2/23/94	1322	54	7.9	1540	0.6	1.19	259	240	280
3/31/94	1345	72	8.1	2000	0.9	1.82	374	293	412
4/27/94	1115	62	7.6	1780	0.6	1.42	245	219	342
5/25/94	945	70	7.3	2350	0.6	2.17	359	422	488
6/29/94	810	71	6.6	2350	0.3	3.75	293	506	544
7/27/94	950	75	8.1	1520	0.6	0.41	210	180	340
8/31/94	1415	86	9.2	2150	1.1	0.93			310
9/29/94	1135	72	7.9	1110	0.8	0.58			280
	Count	12	12	12	12	12	10	10	12
	Min	54	6.6	670	0.3	0.37	72.8	60.6	154
	Max	86	9.2	2350	1.1	3.75	374	506	544
	Mean	67	7.9	1550	0.6	1.23	223	228	314
	Geo Mean	66	7.9	1438	0.6	0.96	199	189	292
	Median	70	7.9	1530	0.6	0.91	228	200	295

Salt Slough at Lander Avenue (State Highway 165) (MER531)

Location: Latitude 37° 14' 55" Longitude 120° 51' 04". In NW 1/4, SE 1/4, SE 1/4, Sec. 10, T. 8S., R.10E. 13.0 mi. north of Los Banos, 5.0 mi. south of Highway 140.

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	Mo µg/L	Cr µg/L	Cu µg/L	Ni µg/L	Pb µg/L	Zn µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/1/93	1304	77	7.6	1040	1.4			7				0.68			308
10/8/93	1247	69	8.0	1220	1.2			4				0.64			263
10/15/93	1015	68	7.9	1450	2.7			7				1.16			304
10/21/93	755		8.0	1670	5.8			5				1.57			380
10/29/93	1239	64	7.5	1780	7.8	9	10	5		<5	15	1.82	245	350	378
11/5/93	830	60	7.4	1700	8.8							1.61			
11/12/93	1059	59	6.8	1580	7.0							1.42			
11/22/93	1145	54	7.6	1870	9.2							1.68			
11/30/93	1100	55	7.7	1870	11	7	7	4	<5	<5	12	1.68	252	365	391
12/3/93	1025	52	7.8	2020	12							1.84			
12/10/93	1300	55	6.9	1960	9.3							2.02			
12/17/93	1155		7.8	1720	9.9							1.64			
12/28/93	1210	47	7.5	2390	12	7	7	14	21	<5	<1	2.44	449	534	581
1/7/94	1211	46	7.9	2510	13							2.46		1260	
1/13/94	1723	50	7.9	2970	21							3.28			
1/21/94	1204	54	7.0	2680	18							2.83			
1/27/94	1353	52	7.6	2480	17	9	11	12	25	<5	8	2.51	339	500	551
2/3/94		50	8.0	2750	22							2.63			
2/11/94	1248	53	7.8	2560	20							2.53			
2/17/94	720	52	6.6	2830	29							3.00			
2/23/94	1345	54	7.3	2290	22	7	12		21	<5		2.53	362	578	510
3/4/94	1136	62	7.3	2640	23							2.41			
3/9/94	749	60	7.6	2690	26							2.62			
3/16/94	1100	64	7.5	2780	20							2.75			
3/23/94	1042	57	7.6	2840	27							2.83			
3/31/94	1630	69	7.7	2750	25	11	8		6	<5	10	3.22	395	622	712
4/6/94	1228		7.6	2820	22							2.71			
4/15/94	1125	72	7.8	2590	19							2.24			
4/21/94	1252	70	7.3	2620	20							2.38			
4/27/94	1156	61	7.8	3000	30	12	9	4	6	<5	6	2.82	405	628	663
5/4/94	1215	71	7.9	3220	32							2.78			
5/10/94	1505	80	7.8	2600	25							2.46			
5/16/94	1155	66	8.2	3740	44							4.07			
5/25/94	1035	74	6.8	3110	31	14	15	7	9	<5	13	3.81	520	842	671
6/1/94	1230	79	7.8	2430	26							2.67			
6/8/94	940	65	8.1	3110	29							3.77			
6/15/94	1150	72	8.1	3470	33							4.71			
6/21/94	1128	73	7.4	2730	27							3.04			
6/29/94	905	79	7.8	2860	33	11	19	7	13	<5		3.61	404	692	735
7/6/94	1140	78	7.8	2660	31							2.40			
7/13/94	1110	80	8.0	3150	42							3.10			
7/21/94	1335	80	7.9	2330	22							2.90			
7/27/94	900	71	7.5	1950	15	7	24	14	20	6	60	2.00	250	430	410
8/3/94	1125	76	8.2	2220	19							2.40			
8/10/94	1230	77	7.9	2410	27							2.70			
8/16/94	1104	79	7.9	2650	24							3.40			
8/24/94	1120	76	7.6	2380	20							3.00			
8/31/94	1545	82	8.5	2040	13	8						2.00			440
9/7/94	1140	76	8.1	1920	15							1.60			
9/14/94	1130	74	8.2	2130	16							2.00			
9/22/94	1155	74	7.7	2330	19							2.00			
9/29/94	1210	72	7.7	2100	16	7						1.80			390
	Count	49	52	52	52	12	10	12	9	10	8	52	10	11	16
	Min	46	6.6	1040	1.2	7	7	4	<5	<5	6	0.64	245	350	263
	Max	82	8.5	3740	44.0	14	24	14	25	6	60	4.71	520	1260	735
	Mean	66	7.7	2420	19.8	9	12	8	14	2	16	2.46	362	618	480
	Geo Mean	65	7.7	2340	16.4	9	11	7	10	1	8	2.32	351	579	458
	Median	69	7.8	2500	20.1	9	11	7	13	1	11	2.49	379	578	425

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